Engineering News-Record

McGraw-Hill Publishing Company, Inc. June 6, 1935 Twenty-five Cents, Five Dollars per Year

LARGEST LARGE-SCALE HOUSING . . . Last Friday the first of 1,416 families that will occupy the Hillside Housing development in the Bronx New York City, moved in. Largest of the PWA limited-dividend projects, Hillside occupies a 14½-acre site, of which its buildings cover about a third.

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CORROSION takes its costly toll of river, harbor and sea-going craft where some other metal has been substituted for the job wrought iron has done so well for years.

Industrial wastes and mine drainage especially have made rivers unusually corrosive. The U. S. Engineers Corps and all other operators of inland water craft are faced with the serious problem of selecting hull and piping material for these severe conditions.

Where should they turn for the solution but to their own records. What procedure should they follow but the sound engineering practice of selecting the material that has given the longest, most economical service.

Because the U. S. Engineers do follow their own service records — because they do select materials on a sound engineering basis, we call your attention to the new tunnel type screw propulsion towboat "Coiner" just completed by the Marietta Manufacturing Company at Point Pleasant, W. Va. The entire hull plating, including straps and double plates, are Byers Wrought Iron. The waste, soil, bilge, heating and exhaust gas piping and the fire system are Byers Wrought Iron Pipe.

Also illustrated is the U. S. Dredge B. M. Harrod whose wrought iron hull has given 28 years of uninterrupted service. Wrought iron is used in new craft because of its reputation in old craft. More information about Byers Wrought Iron Plates, Sheets and Pipe in all types of inland and sea-going vessels is quickly obtainable from any Byers Engineer or our Engineering Service Department. A. M. Byers Co., Est. 1864. Pittsburgh, Boston, New York, Philadelphia, Washington, Chicago, St. Louis, Houston.

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To Organize for *Further* Progress

BY A unanimous decision the Supreme Court now rules out the NRA code structure including the Construction Code with its numerous far-reaching chapters. Thus the construction industry loses the statutory foundation on which it has been trying to build an integrated structure for its administration.

But all this should be no occasion for emotional outburst from either opponents or proponents of the code. Thoughtful men, with the welfare of their industry at heart, will leave to others all jubilation over the political discomfiture of the administration or resentful reproach that their efforts of the last two years may have gone for naught. They will face the reality that whatever may become of its code, the problems of the construction industry still remain: they will save their breath and energy to deal with those problems.

Right now the job is to take stock of progress to date, to contrive means to conserve it and to lay down a program that will enable us to carry on. We must accept the condition that we shall have to do this without benefit of federal enforcing power; our accomplishment must depend for the most part on our own effort. Possibly a legislative formula may yet be evolved to provide some measure of governmental support: on this, however, we cannot now rely.

What then has been achieved by the industry during the last year and a half of its code administration?

FIRST of all, many individuals and groups have become conscious, for the first time, of their identity with the construction industry. Under compulsion of the National Recovery Act they have had to sit down and talk out their problems, first with each other and later with the other groups that constitute the industry. Observe that they have had to talk them *out;* not just talk them over. For it has been necessary to think of them in connection with the problems of other groups and of the industry as a whole. In doing this many have come to see for the first time how interdependent they actually are and how impossible it is for any one group to deal single-handed even with its own difficulties.

Moreover, in doing this it has been necessary to define more accurately than ever before the sources of the evils that beset the industry; in formulating and administering the several chapters of the code it has been necessary to devise methods and machinery for dealing with those evils. Here we have learned something about what will not work as well as what will. Most of all, we have developed among the various groups a mutual understanding and a will to cooperate where two years ago distrust and self-sufficiency prevailed. This has been demonstrated most convincingly since the decision in the determination expressed by many who have not liked the codes that the industry must hold the gains it has made under them.

NOT the least important of these gains is the fact that the industry at last was compelled to work out a pattern for its integration. Then, too, it has glimpsed the power that it might wield outside as well as within its own ranks by effecting unity along lines similar to those prescribed by the code structure. Now the task is to continue, as an industry undertaking, the effort that was initiated with governmental support.

In carrying out such a program it now should be possible for the industry to enlist the support of various groups which, although inherently a part of it, could not, for administrative reasons, be built into its code structure. Notable among these are the various investment groups and the many producers and distributors of construction materials and equipment; no one has a greater stake in the sound conduct of construction.

If, under a voluntary organization, the industry may be unable to realize certain objectives that seemed feasible under the federal code system, it still may be able to achieve many of them, while at the same time it can wield a productive influence in many fields outside the domain of the federal codes.

But whatever be the means and the method, the need today is obvious. The construction industry has made its first stride toward the integration it so sorely needs, and its dominant concern right now must be to conserve its gains and to organize for further progress.

Willard Chevalier

(Note.—Conclusion of the article "Lest Unwise Sharing Kill Production," of which the first section appeared on this page last week, will be published next week.)

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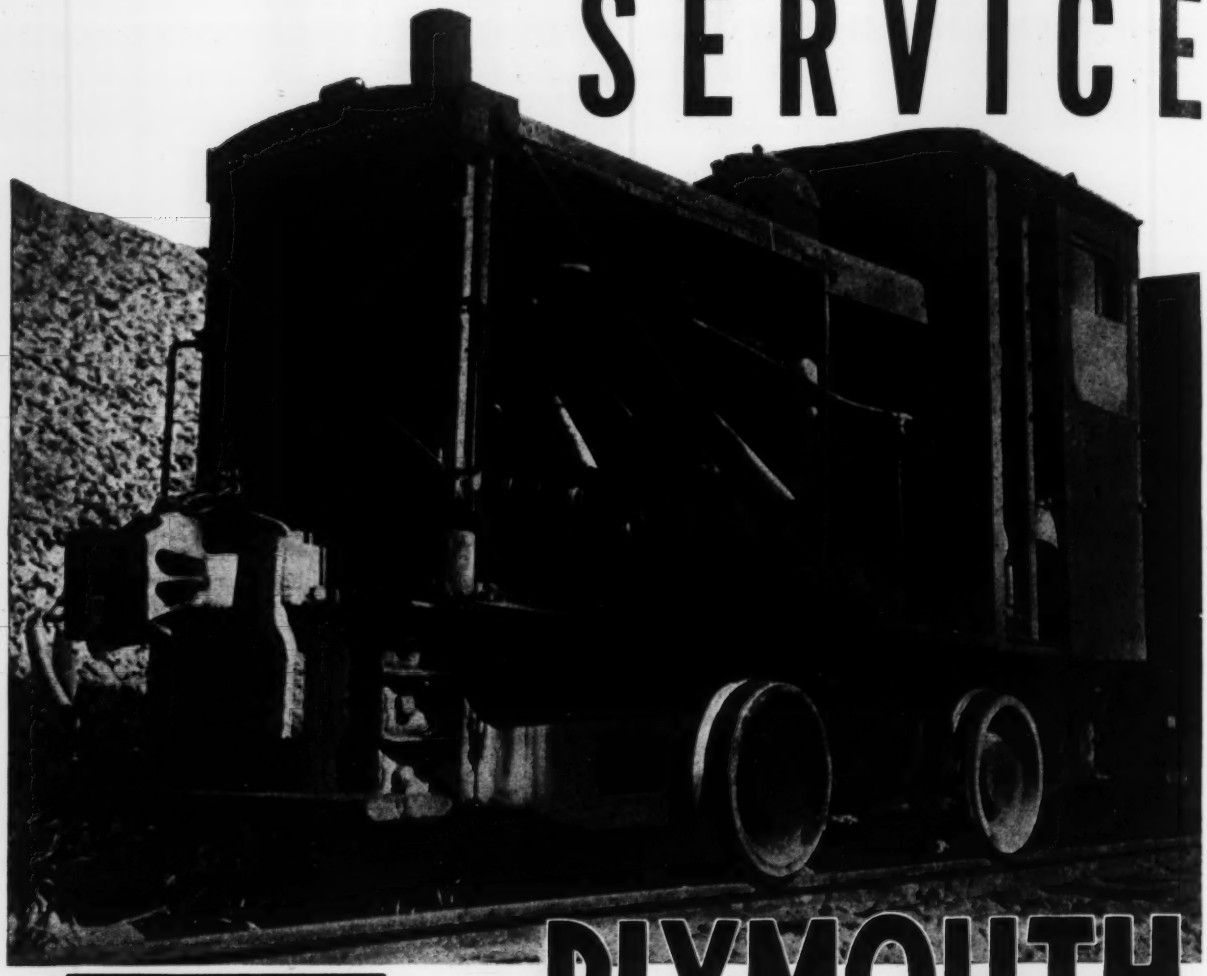

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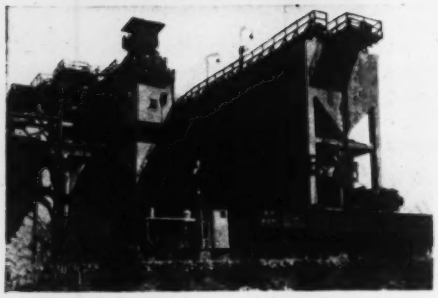

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In the News:

AS A SUBSTITUTE for NRA codes, so far as wages and hours are concerned, New England is talking state compacts, to promote uniformity in labor legislation. A resolution asking federal approval of such a plan was filed in the Massachusetts legislature last week. At the same time and in the same connection, New Hampshire ratified a minimum-wage agreement entered into a year ago by the seven New England states. Massachusetts also has ratified.

THE TOWNS OF EASTPORT AND LUBEC, MAINE, in the Passamaquoddy area, are reported concerned over the inadequacy of their water supply, sewerage system and traffic facilities if the increased population promised by construction of the tidal plant becomes a fact.

LOW VACANCY AVERAGES reported to the National Association of Real Estate Boards prompt Walter S. Schmidt, president, to predict that to fill the nation's housing needs "we must multiply by twelve the construction of the past two years."

THE SIGNING OF A BILL last week by the President, amending the National Housing Act to increase the limit on building-modernization insurance from $2,000 to $50,000, enables loans to be made on business and industrial structures were heretofore they were largely confined to residences.

"MORTGAGES should be made the convenient tool of the home owner and the safe medium of the investor instead of, as now, the executioner's ax of the home owner and the destroyer of the savings of him who lends." Owen D. Young at the inauguration of Purdue's housing research program.

FLOODS took a heavy toll of life and property last week in and adjacent to the region that has just recovered from devastating dust storms. The Republican River Valley in Nebraska and the cities of Colorado Springs, Fort Morgan and Pueblo, Colo., were hit hardest, but damage was also severe in Wyoming, Texas and Kansas.

THE INDIAN EARTHQUAKE that destroyed the British outpost of Quetta, Baluchistan, was one of the most destructive in history, with a reported death toll of some 30,000. Japan's 1923 disaster took 100,000 lives, but a tidal wave accounted for a large number of these. Quetta is located in that much-shaken region that lies between the high Himalayas and the Indian Ocean.

In This Issue:

THE CONSTRUCTION CODE is dead, but the problems that it sought to solve remain. What can be salvaged to aid in these solutions? What new plans must be formulated? Replies to these questions by leading figures in the construction industry constitute an important contribution to this issue.

THE WALLS AND FLOOR of Black Canyon that come in contact with Boulder Dam and with the diversion and penstock tunnels have been thoroughly grouted in one of the most interesting operations of this kind on record. Pressures as high as 1,000 lb. per sq.in. and holes as deep as 150 ft. were involved.

RESEARCH at the University of Illinois is extensive and varied. Dean Enger outlines the projects that are currently under way and recently completed.

SOFT-GROUND TUNNELING on the outlet lines from Owyhee Dam developed some interesting procedure, while rock tunnel work provided some record driving. Four miles long, the tunnel is the longest yet undertaken by the Bureau of Reclamation.

THE SERIES of sewage-plant surveys is continued with data on the plant at Worcester, Mass., the thirteenth to be reported.

RICHMOND, VA., has just completed an unusual program of bridge construction involving five new concrete structures and a remodeled steel viaduct. RFC-financed as self-liquidating toll projects, the designs represent rigid-frame, multiple-arch and bowstring types. Much of the difficult construction was done by relief labor.

ANOTHER interesting toll-bridge group is being built by the state of Oregon along its Coast Highway. Five major structures cross the mouths of streams that empty into the Pacific. An article outlines the traffic possibilities and financing scheme, which is based on a PWA loan and grant.

Coming Articles:

TOWER DESIGN AND ERECTION on the twin suspension spans of the San Francisco-Oakland Bridge set new and interesting precedents. Batter-leg towers are an innovation for such large structures (2,310-ft. main span). Erection by hammerhead cranes received its first tryout. These and other facts will be covered in two articles to be published soon.

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IN its pleasant color combinations and its clean-cut, neat designs, terrazzo makes a floor that's cheerful to the eye. Bright marble chips, color pigments, white portland cement and metal strips combine to build a floor that is good to look at. And besides its good appearance, here's a floor that wears like concrete (it is a form of concrete), that is easy to clean and economical to maintain. For lobbies, for reception rooms, for corridors and entrances, for any place that needs a floor which wears as well as it looks, fine terrazzo fills the bill. Ask your architect for details on this modern flooring material. Or write Universal Atlas Cement Co. *(United States Steel Corporation Subsidiary)*, 208 South La Salle Street, Chicago.

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ENGINEERING NEWS-RECORD

June 6, 1935

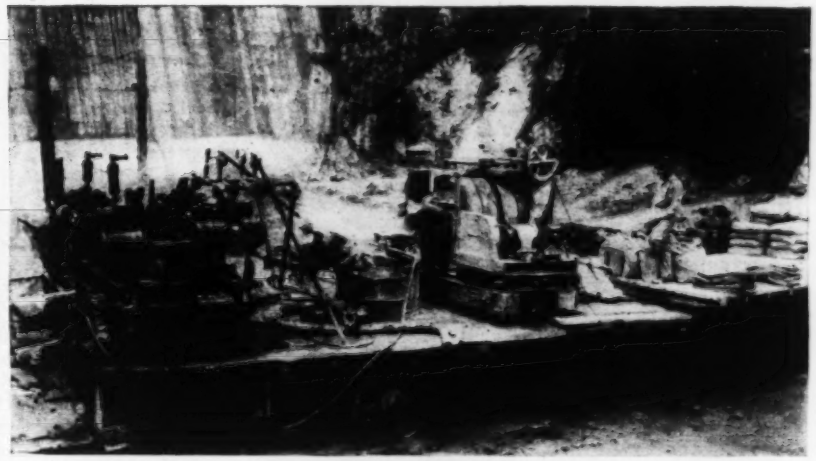


FIG. 1—PRESSURE-GROUTING OUTFIT mounted on truck. Mixer at right discharges into tank, which is the sump for air-driven, high-pressure pumps just behind driver's seat. This rig handles pressures up to 1,000 lb. per sq.in.

Extensive Rock Grouting at Boulder Dam

Grouting was done in the diversion and penstock tunnels as well as under the dam, in part at pressures up to 1,000 lb. per sq.in., and included a complete grout curtain at the abutments of the dam

IN THE PROCESS of constructing Boulder Dam, wherever concrete was poured against rock, advance provision was made for forcing grout into rock fissures and seams, if any, at intervals and depths consistent with the nature of the rock formation and its location with respect to the dam. In addition to grout holes put down in the rock under the dam, radial holes were drilled through the concrete lining of the penstock and outlet tunnels, and both low- and high-pressure grout systems were used to fill any voids there might be behind the concrete linings. Particular attention was given to the rock in the vicinity of the abutments; in these areas holes up to 150 ft. deep were drilled from the tunnels, to provide a continuous curtain of grout extending from the dam into the canyon walls. Pressures up to 1,000 lb. per sq. in. were used at times, in accordance with specifications which outlined the grouting procedure in detail and limited maximum pressures.

The grout was mixed neat (without the addition of sand). In the large tunnels for a while the mixing was done on trailer-mounted platforms; one trailer carried the supply of sacked cement, and another was equipped with mixer, mechanical agitator and air-driven pump. The larger part of the grouting, however, was done by a pump outfit mounted on an automobile truck. This portable outfit could be picked up by cableways and delivered anywhere on the job; also it was able to move under its own power during the grouting process. It was equipped with a ¼-cu.yd. electrically operated mixer arranged to discharge into a tank that constituted the sump for the intakes of two air-operated piston pumps. In the sump tank was a paddle agitator on a vertical shaft driven by a small air motor. Both pumps had surplus capacity for any of the pressures prescribed on the Boulder job. They were connected in parallel, the second unit serving as a stand-by.

Dam grouting

Before any concrete was poured in the dam, holes were drilled in seams of the rock foundation wherever any water was flowing as springs. The seams were then calked with lead wool to force all water to flow through the drill hole. Pipes 1½ in. in diameter were calked in the holes; pipes from the various holes were led into mains and the mains were continued to a grouting gallery in the dam or to the vertical 8-ft. slot on the middle line of the dam that was provided to accommodate the headers of the cooling-pipe system. Generally, the head on the water was not sufficient to cause discharge into the gallery to which the mains were led. After concrete in the dam had been poured to a depth of

at least 100 ft. above the foundation, had been cooled and had the joints between its component 50x50-ft. blocks grouted, these holes into the seams were grouted, at pressures up to 500 lb. per sq.in.

Most of these holes were 30 ft. deep. By far the larger number of them were located in the inner gorge of the river-bed, i.e. below El. 600. Rather extensive drilling was done along two faults situated just upstream of the dam. For convenience on the work these were known as the "major" and the "minor" faults. No major fault grouting was done on the Nevada side of the river. Along these faults, holes usually 50 ft. in depth were drilled and were grouted with pressures ranging up to 500 lb. per sq.in.

The main grout curtain or cutoff for the dam was made by three systems of holes, A, B and C in Fig. 2, which were drilled as follows: The B holes, 30 to 50 ft. deep and spaced 20 ft. on centers, were drilled and grouted before any concrete was poured. The C holes, drilled from outside the foundation of the dam at 10-ft. spacing to a maximum depth of 100 ft., were grouted with pressures up to 900 lb. per sq.in. prior to drilling the A holes. The A holes were drilled from a gallery in the dam, which closely follows the rock foundation and ordinarily is about 15 ft. from it. These holes were put down at 5-ft. spacing, to a maximum depth of 150 ft. under the dam and to depths of 50 to 150 ft. in the rock of the abutments. They were grouted at pressures up to 1,000 lb. per sq.in. Some cores were taken from these holes as a check on the effectiveness of grouting through the C holes. The A and C holes have a total length of about 87,000 ft., and the grout placement averaged about 0.8 sack of cement per foot of hole. Drilling of the drainage holes was done subsequent to all grouting.

Drill bits

Grout holes at Boulder Dam were drilled with bits of two sizes, a standard 2-in. diamond drill and a special 1-in. bit which is essentially a hemisphere studded with diamonds used to grind up the rock. This bit was cooled, and the hole continuously cleaned by a water jet. Working in the open, the length of the rod sections was 10 ft. In the constricted quarters within the inspection gallery in the tunnel, rods with joints at 5-ft. intervals were used.

Grouting in the area of contact between the dam concrete and the rock against which it was poured is to be accomplished by a pipe system from within the dam. These pipes were placed 10 ft. apart vertically and staggered 10 ft. apart horizontally. Their purpose is solely to seal the rock-concrete contact; they will be grouted after the dam has taken full water load. The arrangement of these grout-pipe connections is shown in Fig. 3.

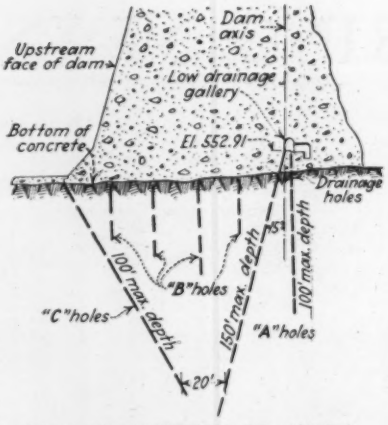


FIG. 2—CROSS-SECTION of Boulder Dam base, showing location of A, B and C holes for pressure-grouting of foundations.

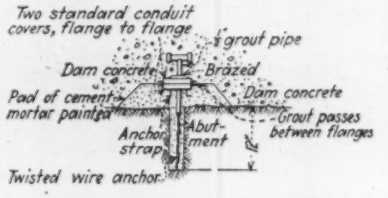


FIG. 3—PIPE CONNECTION for grouting contact area between rock foundation and concrete of dam.

The grout outlet is composed of two standard circular conduit covers placed with their flanges together, to form a metal box. While the concrete of the dam is being poured, the two halves are held together by wire. To the inner or abutment half of the metal box an anchor strap is welded, to help hold it in a pad of cement mortar placed around a drill hole, 1 ft. deep. A ½-in. pipe and twisted anchor wire as shown also aid the fastening. To the outer half of the metal box is brazed a T-connection of the ½-in. thin-walled pipe used for grouting within the dam. After the dam concrete has set, grout is forced in through this ½-in. pipe, escapes between the two flanges of the metal box and then passes into whatever voids or cracks there may be.

Grouting of the radial and circumferential contraction joints in the dam is to be accomplished by pipe systems from convenient points in galleries within the dam. Cement used is standard portland cement re-screened through a 200-mesh screen. Grout stops are made with copper sheets as usual. For waterstops, however, Monel metal was chosen for durability. This metal was brought to the job in 5-ft. sheets, and joints between adjacent sheets were welded before the surrounding concrete was poured. More detailed data on grouting the joints within the dam itself appeared in *ENR*, Oct. 11, 1934, p. 454.

Tunnel grouting

For the diversion and penstock tunnels two grouting systems were planned: (1) a series of low-pressure holes in the arch section to fill the voids between the pneumatically placed concrete and the rock, and in the invert and lower side wall, to fill gravel drains; and (2) a high-pressure system extending further into the rock, intended to grout seams and cavities where such might occur in the rock itself. The deep grouting was done only after the low-pressure grout had set up well.

Placement of the grout was permitted by the specifications either through pipes embedded in the concrete lining of tunnels or through grout holes drilled through the concrete. The contractor preferred drilling holes after the lining had been placed, and did the work from a special steel jumbo, remodeled from the one used in the trimming operations during the tunnel driving. Because some of the holes were staggered, fourteen drills were mounted on each jumbo, so as to complete in a single operation all the holes required in walls and arch at any point in the tunnel. Invert holes were drilled with a wagon drill. After drilling, pipes were set in the holes and fastened in place with calking and grout, to await arrival of the pressure-grouting outfit.

The specifications required that grouting in any hole should not be stopped until the hole, while under specified grouting pressure, took grout at a rate of not more than 1 cu.ft. in 10 min., and that after the grouting the pressure should be maintained by means of a stopcock or other suitable device until the grout had set sufficiently to be retained in the hole.

Low-pressure grouting (ordinarily ranging from 50 to 100 lb. per sq.in.) usually was done in the tunnels through three holes in the crown drilled radially, one in the center of the crown and one at 45 deg. on either side. These were 1½-in. holes driven just through the concrete lining. The radial holes were put in at intervals of 20 to 26 ft. 8 in. measured along the tunnel center line. In addition to this regular series of low-pressure holes, all points of overbreak also were provided with individual grout pipes and vents. In some cases the vents had to be capped while grout was applied to pipes near by. The capping was only temporary; finally all holes were grouted. Typical vent-hole conditions are shown in Figs. 4 and 5. The drainage holes, shown in Fig. 4, were drilled after the grouting was finished and were located between the low-pressure grout holes. The ¾-in. vent pipe was inserted in the vent hole drilled through the concrete. Connection between the ¾-in. pipe and the 1½-in. nipple was made by a ¾-1½-in. screw bushing. The locations for drilling the vent holes into the points of overbreak were determined from the tunnel excavation survey.

The high-pressure grouting, using a pressure of 300 lb. per sq.in. was done by means of eight holes per ring in the 50-ft. tunnels and six holes per ring in

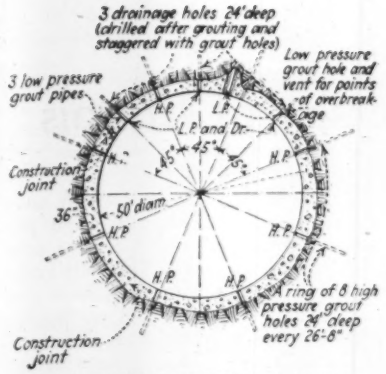

3 drainage holes 24' deep (drilled after grouting and staggered with grout holes)
Low pressure grout hole and vent for points of overbreakage
3 low pressure grout pipes
L.P.
L.P. and Dr.
45°
H.P.
Construction joint
36'
50' diam
A ring of 8 high pressure grout holes 24' deep every 26'-8"
Construction joint

FIG. 4—TYPICAL SECTION of diversion tunnel, showing low- and high-pressure grout holes. Drainage holes in crown are drilled staggered with grout holes after grouting operations.

the smaller tunnels. In successive rings the holes were staggered—that is, drill positions were rotated approximately 23 deg. between settings in successive rings. High-pressure holes in tunnels of both sizes were drilled 24 ft. deep. Drainage holes spaced 28 ft. 8 in. apart were drilled to drain water from the rock or from back of the lining. They were put in only after grouting was finished.

In the 50-ft. diversion tunnels a total of 122,000 lin.-ft. of grout holes in 16,000 lin.-ft. of tunnel took grout at the rate of about ten sacks per linear-foot of tunnel, while in the smaller (penstock) tunnels 9,000 ft. of holes took grout at the rate of about five sacks per linear-foot of tunnel. In all tunnels and for both low and high pressures alike the amount of cement taken up was about 1¼ sacks per linear-foot of grout hole.

In addition to the low- and high-pressure grouting systems, the contractor was required to grout any temporary drain systems left in the tunnel invert. Although the tunnels were comparatively dry, the excavation of the invert section brought some water into the bores, and this was taken care of during placement of the lining by means of drainage pipes, extended along the rock for varying distances, sometimes several hundred feet, and then brought to the surface of the invert concrete. This drainage system was grouted prior to the placement of the high-pressure grouting; a maximum pressure of 50 lb. was used in this work. Grouting operations were finished before the end of 1934, except in diversion tunnels No. 1 and No. 4.

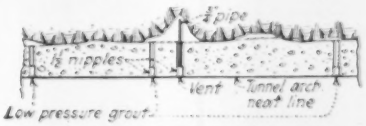


FIG. 5—LONGITUDINAL SECTION, showing relation of low-pressure grout and vent holes in tunnel lining.

Grouting the Boulder Dam is part of the contract of Six Companies Inc., for which Charles A. Shea is director of construction, F. T. Crowe is general superintendent, and A. H. Ayers is chief engineer. The contract is carried out under the direction of the U. S. Bureau of Reclamation, Dr. Elwood Mead, commissioner, R. F. Walter, chief engineer, and Walker R. Young, construction engineer.

As a Lawyer Sees Engineers

INTERESTING opinions as to engineers and their work are found in an address by Harold Drew, a lawyer of Derby, Conn., before a recent meeting of members of his profession in New Haven. Mr. Drew was speaking on the Tennessee Valley Authority, giving attention, generally, to the aspects that are of special interest to lawyers. But speaking aside from the legal aspects for a moment, he made the following comment:

"The material published in the last six months about the TVA is astounding. The legal publications and magazines are full of it. Almost every day the press carries something about it. I started in to read all I found, but was soon swamped with material, especially by that in the *Public Utilities Fortnightly* and the *Engineering News-Record*. Many of the daily press items appear to have their background in propaganda efforts of the TVA or of the public utilities.

"It was refreshing to me to read the articles in the *Engineering News-Record*. This was, undoubtedly, because they were articles largely by engineers for engineers. They are little troubled by legal problems or theories of government. Engineers are builders and scrutinize things almost wholly from a practical standpoint. Is the project sound from a business standpoint? Is it economically good? Thus their discussions of the TVA refer a great deal more to other similar projects, such as Boulder Dam, Grand Coulee Dam, Bonneville Dam, Alcova Dam and Fort Peck Dam. Engineers hate to see a project started until the whole plan is in hand and carefully weighed. Their doubts about the TVA are largely due to the fact that work is under way here and there in connection with it, when the whole thing is as yet not completely planned nor coordinated. So, too, with respect to all the other dams mentioned above, except the Boulder Dam. The Boulder Dam project is one which delights engineers because it was a fully planned development before it was started. So far as power was concerned, a market for the whole business was found and tied up by contracts before work was started. Its costs were budgeted, based on contracts to liquidate itself. There was no creation of power and then running around trying by hook or crook to sell it. There appears to be no wreckage or economic waste in its trail. It is a thing of beauty to the engineering mind.

"Not so the TVA dams nor the other dams rushed into construction or prospective construction by the flood of emergency money turned loose. They hate to see log rolling in Congress take the place of engineering advice. If one were to state the principle or general rule applied by the engineers to these things, it would undoubtedly be that no great power development should be undertaken without first having reasonable assurance that the power can be marketed in a reasonable time without entering into destructive competition with existing plants.

"The engineers are also a bit startled to find that, after years of effort to wheedle out of Congress appropriations for engineering work, the plans for which were completed, suddenly all these great power projects, most of which are but partly planned, are proceeding under direction of the President without specific Congressional approval, because the Boulder Dam and Norris Dam are the only ones specifically authorized by Congress.

"Although the engineers are dazzled by and very proud of, the spectacular construction operations that they are engaged in, nevertheless they are asking questions such as these: Why were these projects undertaken? How do they fit into plans for the orderly development of their respective river systems? How are they related to the economic development of their respective regions? Are they economically justified, either in part or in whole? Is there a market for the power to be developed? Are the power plants logical additions to power systems in their regions, or are they bound to be destructive of existing systems because of the creation of surplus power? Will the land to be irrigated ever produce a return on the investment? So much for the engineers. I take my hat off to them. They are at the real bottom of the whole problem. Things that are economically sound usually find expression in constitutions and laws."

Research Notes

Current Investigations at the University of Illinois

PREVIOUS ARTICLES in this series devoted to reviews of current projects in the college laboratories have been published as follows: Feb. 15, 1934, p. 225; May 24, 1934, p. 666; March 28, 1935, p. 455; and April 25, 1935, p. 588. —EDITOR.

SINCE the establishment of the Engineering Experiment Station at the University of Illinois in 1903, engineering research by both station and teaching staffs has been given continued encouragement and support. As a tangible result, there have been published, to date, 272 bulletins and 23 circulars, which give the results of the investigational work. Some projects are carried on entirely on station resources; others are conducted in cooperation with outside organizations that contribute to the financial support of the work in which they are interested.

The Materials Testing Laboratory, completed in 1929, houses the laboratories of the departments of theoretical and applied mechanics and civil engineering. It provides facilities for research in structural, highway and sanitary engineeirng, fatigue of metals, general materials testing, hydraulics, metallography, timber, reinforced concrete and other building materials. The large crane bay, served by a 10-ton crane 50 ft. above the floor; the 3,000,000-lb. testing machine accommodating tension or compression specimens 38 ft. long and served by an electric elevator; about 30 fatigue-tension machines of various types; about 350 ft. of large open hydraulic channel; a 65-ft. standpipe; and two well-equipped machine shops are outstanding features of the laboratory.

Some of the principal current research projects of interest to civil engineers (including a few conducted in the field rather than the laboratory) are described in the following paragraphs:

Stresses in railroad track

The investigation of stresses in railroad track has been in progress since 1914. This twenty-year study was necessarily based upon experimental data derived from extensive tests on standard railroad track, in many cases supplemented by laboratory tests. Tests of numerous kinds have been conducted throughout the country on many of the railroads.

Some of the more important subjects reported on are as follows: (1) analytical treatment of the action of track as an elastic structure; (2) stresses in rail on straight track; effect of speed and counterbalance, including the effect of differences in the planes of rotating parts; (3) stresses in curved track; (4) effect of various types of steam and electric locomotives and cars on track at various speeds; (5) a study of the action of cross-ties in track; (6) effect of canted rail and inclination and eccentricity of tieplates; (7) transmission of pressures in ballast; (8) effect of size of rail and wheel spacing; (9) a study of the quality and uniformity of standard and special track constructions, including concrete roadbed; (10) a study of the action of the rail joint from analysis and from laboratory and field tests; action of various types of rail joints and their behavior under static loads and moving loads up to 90 miles per hour; a study of the design of the joint bar.

The investigation has been carried on in cooperation with the Association of American Railroads, the American Railway Engineering Association, and the American Society of Civil Engineers. Six progress reports, comprising about 1,200 printed pages, have been published in the A.R.E.A. *Proceedings*, Vols. 19, 21, 24, 26, 31 and 35.

Repeated-load tests of welds

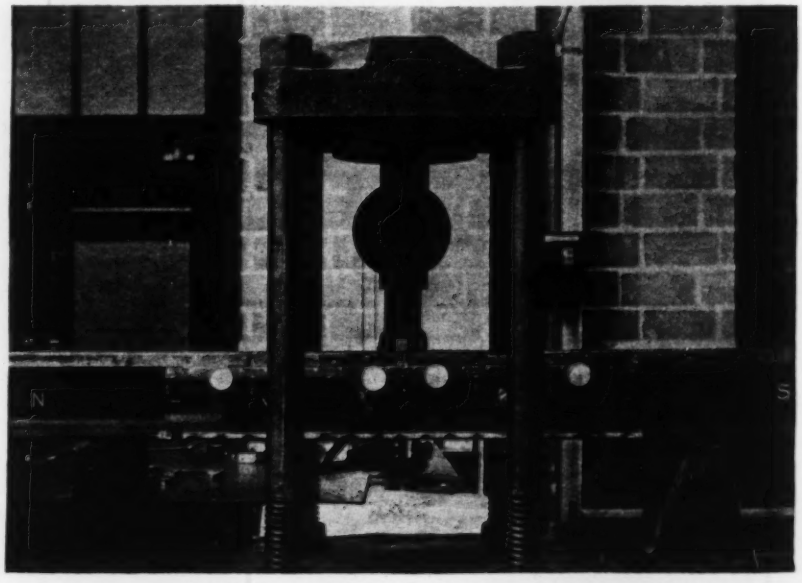
The repeated-load tests of welds form a part of an investigation to determine the feasibility of welding the steel frame of a skeleton building for complete continuity. The specimens being tested are moment-resisting joints connecting 12-in. I-beams and 12-in. H-columns. The joint is subjected to a stress cycle which, when the moment is of one sign, produces a tension, at the top of the beam at the junction with the column, of 24,000 lb. per sq.in., and which, when the moment is of the opposite sign, produces a compression at the same point of 12,000 lb. per sq.in. These are representative of the maximum stresses used in the design of wind and earthquake-resisting parts of a structure. The speed of the test machine is such that there are about 30 stress cycles per minute. The purpose of the tests is to determine the number of these stress cycles necessary to cause the connection to fail. Five types of connections are being used, and several specimens of the type that appears to be the most practicable will be tested. The investigation is being conducted in cooperation with the Hollup Corp.

Repeated-load tests of joints

The repeated-load tests of riveted joints are a part of the investigation of the action of riveted steel tension members being made in connecion with the San Francisco-Oakland Bay Bridge. The first part of the investigation will consist of tests of comparatively small joints having not more than four 1-in. rivets each. The tests will be made in a specially designed machine that will produce in the specimen alternate stresses of tension and compression. The magnitude of the stress can be changed as desired.

The variables to be studied include the grip of the rivet, relation of maximum to minimum stress in the stress

TEST SET-UP used to determine the stress in a rail joint equipped with special bolt-tension indicators.



cycle, the spacing of the rivets, kind of material in plate and rivet, and the method of making the holes in the plate. The tests on the four-rivet specimens will be followed by tests on connections containing a larger number of rivets. This investigation is being conducted in cooperation with the California department of public works. No results are available, to date.

Tests of three-span arches

Tests of three-span arch series have been made in cooperation with the U. S. Bureau of Public Roads, and are a part of the investigation that was sponsored by the committee on concrete and reinforced-concrete arches of the American Society of Civil Engineers. Each arch had a span of 27 ft. and a rise of 6 ft. 9 in. For some specimens each span consisted of a rib without deck; for others, a rib, spandrel columns and a deck were utilized.

The superstructure varied for the different structures. For some the deck was so low as to be integral with the rib at the crown, for others it was a considerable disance above the rib; for some, the deck contained expansion joints at the piers only, for others there were expansion joints over the piers and intermediate expansion joints near the one-third points of the span. The various specimens were tested at pier heights of 20, 15 and 10 ft.

Each specimen was loaded with concrete blocks of known weight. The abutments and pier bases were mounted in such a manner that, separately, they could be given each of the components of movement (x, y and θ), and the magnitude of each component of movement could be measured. Moreover, scales were provided for weighing separately each of the three reaction components at each abutment and at the base of each pier.

The investigation included tests to determine the elastic properties of the structure, the influence ordinates for the reaction components at both springings of each span, the unit stresses in the rib due to the design load, and the ultimate load-carrying capacity of the structure.

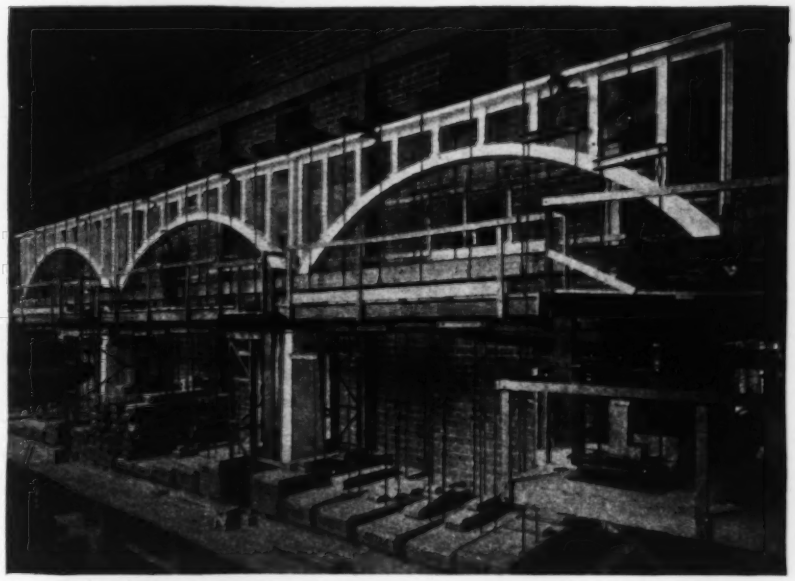
These tests gave many results that are of interest to the designer, but probably the two most important conclusions are: (1) the elastic theory, as applied to a three-span arch series, gives results that agree with the tests; and (2) concrete in an arch rib develops practically the same strength as the same concrete in 6x12-in. control cylinders. There was also developed a combined algebraic-and-experimental method for analyzing multiple-span structures with decks, which should be useful to bridge engineers.

The investigation was conducted in cooperation with the American Society of Civil Engineers, the Engineering Foundation, the U. S. Bureau of Public Roads, and various companies that manufacture bridge materials. The following reports of the investigation have been made, to date:

"Laboratory Tests of Multiple-Span Reinforced-Concrete Arch Bridges," by W. M. Wilson. *Proc.*, A.S.C.E., Vol. 60, p. 485. April, 1934.

Bulletin 269, "Laboratory Tests of Three-Span Reinforced Concrete Arch Ribs on Slender Piers," by W. M. Wilson and R. W. Kluge. September, 1934.

Bulletin 270, "Laboratory Tests of Three-Span Reinforced-Concrete Arch Bridges with Decks on Slender Piers," by W. M. Wilson and R. W. Kluge. In press.



TESTING a three-span arch bridge in which spans have a length of 27 ft. and a rise of 6 ft. 9 in.

Rigid-frame bridges

This investigation, undertaken recently in coperation with the Portland Cement Association, is divided into two parts: (1) tests of a series of rigid-frame bridges, and (2) tests of a large number of knee frames. The bridges have a span of 30 ft. and a height or rise of 8½ ft. They are designed as highway spans and are tested in a manner similar to that used in the previous three-span arch tests. The testing apparatus permits the accurate weighing of horizontal and vertical reactions; it also permits the introduction of a known rotation, settlement or lateral movement of either base.

The tests involve a study of the effect of such movements upon moments and stresses throughout the frame, as well as the measurement of reactions, moments and stresses under gravity loads, applied in increments to failure. Both hinged and fixed bases are used, and variations in design are introduced in the different frames.

The tests of knee frames permit the study of a much greater variety of corner details than could be included in the bridge tests. The effect of the sharp re-entrant angle at the inside of the knee upon both strength and stiffness is being studied, as well as the effect of fillets or brackets of various kinds, and the use of compression reinforcement. In both the bridge frames and knee frames the effects of time yield and shrinkage are being investigated. No results are available for publication to date.

Bearing value of small rollers

Tests on small rollers were made to determine the allowable bearing value for the expansion rollers and rockers of bridges. Both static and rolling tests were made. In the static tests, measurements were taken to determine the minimum load which, with a single application, would produce a detectable set in the roller or base. In the rolling tests, the roller was rolled 1,000 strokes at each of a number of increasing loads, to determine the minimum load that would cause the material in the roller or base to flow.

The variables studied included the diameter of the roller and the strength of the material. The diameter varied from 2 to 120 in. The materials included steel of structural grade, medium-grade steel castings and high-carbon tool steel. For all materials, some rollers were tested after the material had been "stress-relieved" by heat treatment, and others were tested after the steel had been hardened by heat treatment.

For most tests, rollers and bases that were tested together were of the same material and had been subjected to the same heat treatment. These tests have resulted in the revision of those sections of the A.R.E.A. specifications for railway bridges which govern the design of rolling-lift bridges and of the expansion rollers and rockers of fixed spans. A report of these tests has been

published in *Bulletin 263*, "The Bearing Value of Rollers," by W. M. Wilson, 1934.

Thin cylindrical shells as columns

An investigation of thin cylindrical shells was made to determine the axial load that could be carried by these shells when loaded as columns. Two types of specimens were used: (1) small specimens accurately machined, and (2) large specimens that were fabricated by welding or riveting. The small specimens were of two diameters, 4 and 14 in. They varied in length from 2 to 20 in. and in thickness from 0.009 in. to 0.06 in.

There were two series of large fabricated specimens tested. For one the specimens were 80 in. in diameter, 6 ft. long, and the shell was 0.25 in. thick. For the other series the shells were 34 in. in diameter and 0.125 in. thick. The lengths for the latter series were 35, 20 and 6 ft. The object of the tests was to determine the load required to wrinkle the shell.

The investigation led to the following rules suggested for the working stress P, to be used in designing thin cylindrical steel shells that function as columns for which the ratio of the length to the radius of gyration does not exceed 35:

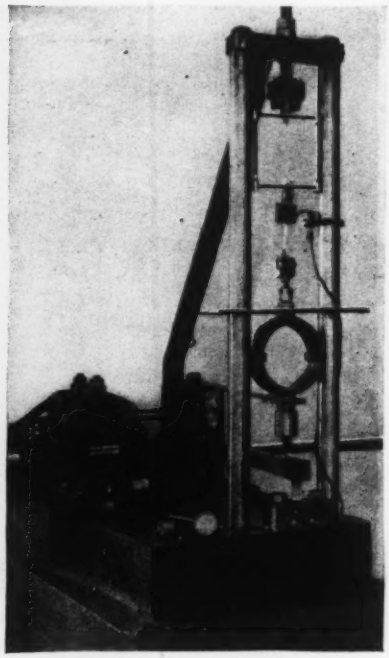
For machined specimens or cold-drawn tubing, straight and free from local indentations, $P = 2{,}000{,}000\,\frac{t}{R}$ lb. per sq.in., but is not to exceed one-half the proportional limit of the material in tension.

For fabricated specimens, straight and free from local indentations, and containing no girth seams of lap type $P = 1{,}600{,}000\,\frac{t}{R}$ lb. per sq.in., but is not to exceed one-third of the yield point of the material in tension.

The working stress P is the maximum stress to be found on any portion of any section. It includes the average stress over the transverse section due to an axial load, the flexural stress due to eccentricity of the axial force or other causes, and any localized stress due to the manner of loading or supporting the cylinder. The investigation was made in cooperation with the Chicago Bridge and Iron Works, and a report has been published as *Bulletin 255*, "The Strength of Thin Cylindrical Shells as Columns," by W. M. Wilson and N. M. Newmark, 1933.

Fatigue-testing machines

For some fifteen or sixteen years the Materials Testing Laboratory has been actively engaged in the study of the so-called "fatigue" of metals under repeated stress. During that period there have been designed and constructed in the laboratory some half-dozen types of fatigue-testing machines, ranging from



REPEATED-TENSION fatigue-testing machine with a specimen of lead.

machines for small specimens running at a maximum speed of 30,000 cycles of stress per minute to machines capable of making fatigue tests of full-sized railroad rail. These machines are described in considerable detail in *Circular No. 23* of the Engineering Experiment Station.

Rails investigation

There is in progress at the present time an extensive investigation of railroad rails, which is being carried on under the joint auspices of the University of Illinois, the association of American Railroads, and the Rail Manufacturers' Technical Committee. *Bulletin 212*, "Stresses Due to the Pressure of One Elastic Solid Upon Another," by H. R. Thomas and V. A. Hoersch (1930) gives a mathematical solution of the complex stress distribution which exists in a rail head directly under the wheel load.

Fatigue strength of bolts and screws

At the root of a screw thread on an ordinary machine screw there is a very high concentration of strain. Under ordinary loads this is not serious because this strain is largely plastic. However, under repeated loading there is the liability of the formation of a spreading crack, a "fatigue" failure. Studies of this stress concentration at screw threads have been carried out both by means of analysis of stress distribution by polarized light and by means of fatigue tests and published as follows: *Bulletin 245*, "Determination of Stress Concentration in Screw Threads by the Photo-Elastic Method," by S. G. Hall, 1932; and *Bulletin 246*, "The Strength of Screw Threads under Repeated Tension," by H. F. Moore and P. E. Henwood, 1934. The conclusions drawn from these two investigations is that for ordinary steel bolts the stress should be computed as $3P/A$ where P is the axial load and A the area at the cross-section at the root of the thread. For heat-treated alloy steel bolts, $4P/A$ is recommended, as heat-treated alloy steels are more sensitive to "stress raisers" at screw threads than are the ordinary structural and machine steels in use.

Calibration of testing machines

The calibration of the load-weighing apparatus of testing machines has been a matter of study in this laboratory for some time. A combined method using dead weights (or proving levers) in combination with the measured stretch of an elastic bar has been developed. Increments of load are put on up to the capacity of the dead weights (or proving levers), and then the weights are removed and the same load is applied to the elastic bar, noting the reading of an attached strainometer. Another increment of load is then applied by the weights, while the reading of the elastic bar is kept constant by operating the machine. In this way the machine can be calibrated step by step to its full capacity. It is not necessary to know the constants of the elasic bar; it is merely necessary to have a sensitive strain-measuring apparatus and to conduct the tests under conditions of fairly constant temperature. Using this method, a 600,000-lb. machine has been calibrated to full capacity, using two 10,000-lb. weights loaned by the Bureau of Standards and an elastic bar with a gage length of 50 in. (*Proceedings*, A.S.T.M., Vol. 32, Part 2, p. 778, 1932.)

Monolithic concrete walls

A series of tests of monolithic concrete walls, just completed, has been carried on during the past year in cooperation with the Portland Cement Association. The tests are similar to the recent investigation conducted here on concrete masonry walls. (*Bulletin 251*, "Strength and Stability of Concrete Masonry Walls," by F. E. Richart, R. B. B. Moorman and P. M. Woodworth, 1932). The tests included 27 large wall panels, 6x9 ft., of solid, hollow and ribbed types, together with wallettes and small test pieces. All types were tested under uniformly distributed axial loads; in addition, several were tested in flexure and under eccentric vertical loads. Most of the solid and hollow walls were of dry-tamped concrete, placed with sliding forms. The ribbed walls and some solid walls were made of poured concrete. The tests form a part of an investigation into the question of what wall thickness is needed for

residence and apartment construction. It is interesting that the compressive strength of all axially loaded walls was over 55 per cent of the strength of the concrete control cylinders and averaged 78 per cent of the cylinder strength, even though the thickness of walls was as small as 4 in. for single walls and 3 in. each for the double walls. The flexural strength of the dry-tamped walls was dependent upon the adhesion between successive courses, placed at intervals of about two hours. A progress report was presented at the American Concrete Institute convention, Feb. 19, 1935—"Structural and Economic Studies of Monolithic Concrete Walls for Dwellings," by N. M. Newmark and R. E. Copeland.

Laminated timber floors

For several years an investigation has been under way to determine the distribution of concentrated loads on laminated timber floors. Floor slabs composed of 2x4-in. and 2x6-in. laminations nailed and bolted together in spans of 3 and 6 ft. are being investigated, to determine the effective widths and the load on each connecting element. This investigation has been carried on in cooperation with the National Lumber Manufacturers Association and is quite far advanced. It has shown that, for concentrated loads, the spacing of nails should be about one-fourth of the span, that the nails directly under the load carry a large proportion of the load, and that, with a concentrated load at the center of one lamination, the maximum fiber stress in a laminated slab varies from about ⅓ to about ¼ of the value that would be secured for the same load at the center of a single lamination; the actual distribution in any case depends upon the span length, the depth of the slab, the magnitude of the load and other factors.

Laminated timber arches

Two-hinged arches built up of thin laminations glued together, with a span of 17 ft. 6 in., are being tested with unsymmetrical loading, to determine the effectiveness of this form of construction and to compare measured strains and horizontal reactions with values computed by the elastic theory. Three arches have been tested, and a fourth is being prepared for testing. In general, there has been excellent agreement between the observed and computed values for the horizontal reactions and a satisfactory agreement between the observed and computed strains in the fiber of the arches.

Distribution of load to timber stringers

A study of the distribution of wheel loads to the timber stringers supporting a laminated floor deck has recently been completed. Six 4x14-in. fir stringers with a span of 16 ft., spaced 3 ft. on centers and supporting a 2x6-in. yellow pine laminated deck, were loaded with one concentrated load. The distribution of the load was determined from the deflection of the stringers. The results obtained from the test of one full-size panel showed that the accepted methods of distribution were at least adequately conservative. The report of this test has been published recently in *Bulletin 374* of the A.R.E.A., February, 1935.

Creep of concrete

The tests of creep or time yield in reinforced-concrete columns are a continuation of the general investigation of columns begun in 1929 in cooperation with the American Concrete Institute and Lehigh University. Sixteen reinforced-concrete columns have been held for five years under a sustained design load, with a like number of companion columns under no load. The result of creep and shrinkage of the concrete has been an increase in steel stress (to values as great as 33,000 lb. per sq.in.) and a corresponding decrease in concrete stress. The major part of the creep occurred during the first year, and there has been only a slight change in the last three years. The tests have been reported in part in *Bulletin 267*, "An Investigation of Reinforced-Concrete Columns," by F. E. Richart and R. L. Brown, June, 1934.

REINFORCED-CONCRETE column, 32 in. in diameter, undergoing test in the 3,000,000-lb. machine at the University of Illinois. Beyond the large machine is a 600,000-lb. testing machine.

Tests of the effect of creep of concrete are also being made on ten rectangular rigid frames, about 6 ft. high and 8 ft. wide. A sustained design load has been held on these frames for three years. Measurements are taken of strains in concrete and in tension and compression reinforcement, of deflections, angle changes at corners of frames and of horizontal thrusts at bases. The present values of concrete strains, deflections and angle changes are three to six times the initial values. Stresses in tensile steel have slightly exceeded design values, while those in compressive steel have reached 40,000 lb. per sq.in. and more. Results for the first two years' observations have been published in *Proc.*, American Concrete Institute, Vol. 30, p. 181, 1930: "The Effect of Plastic Flow in Rigid Frames of Reinforced Concrete," by F. E. Richart, R. L. Brown and T. G. Taylor.

Eccentrically loaded concrete columns

Tests of more than 100 eccentrically loaded columns were begun recently, to provide information needed by designers. Aside from a few tests made in Germany in 1913 and unpublished tests made at this laboratory in 1916 and 1925, there is little basis for the empirical design formulas now in use. This series includes both tied and spiral columns, round and square, with and without a protective shell of concrete outside the reinforcement. Attention is given to the conditions of bending in corner columns. Strains, deflections and rotation of ends are being measured. Eccentric load is applied through roller-bearing shoes, producing bending in one plane only. To study the effect of creep, one group of columns is being tested under sustained eccentric loads. No results are available, to date.

Flow of water by photographs

The object of this photographic study is to obtain information relative to turbulence, mixing lengths and other phenomena related to the flow of water in circular conduits. Motion pictures are taken of water flowing through a glass pipe. The movement of the water is made visible by projecting horizontally a thin flat sheet of light of high intensity through the diametral plane of the pipe. The fact that the light is reflected from small globules of an insoluble mixture of carbon tetrachloride and benzene makes such photography possible. An analagous set of conditions occurs when dust particles in a darkened room are made visible by a beam of sunlight.

The particles of the material are introduced with the water at the entrance

of the pipe, and inasmuch as they are small and have the same density as the water, it is assumed that their presence does not influence the characteristics of flow. After the pictures are taken they are projected on a screen, enlarged a number of times and analyzed for the phenomena stated above. The tests were reported before the 1934 summer meeting, Aeronautic and Hydraulic Divisions, Am. Soc. of Mech. Eng., by E. E. Ambrosius, J. C. Reed and H. F. Irving.

Pipe elbows as water meters

In the hydraulic laboratory the possibility of using an elbow in a pipe line as a means of measuring the flow of water has been investigated. ("Flow of Water Around Bends in Pipes." Discussion by W. M. Lansford. *Proc.*, Am. Soc.C.E., November, 1934.) Tests have been made of several elbows of different diameters and of different radii. The difference in pressure between the inside and outside of a given bend was found to be very nearly a constant times the velocity head in the pipe for velocities exceeding about 1 ft. per sec. For accurate work each elbow should be calibrated, but once the constant is known an elbow may become a very economical meter and will cause no appreciable loss in head. On the basis of the information gained from these tests a very useful device known as a flow indicator has been built and is being used successfully in the hydraulic laboratory. This instrument, which is connected to an elbow near the discharge side of a centrifugal pump located in the basement of the laboratory, lights an electric lamp above the pump-control panel, located on the first floor, when the pump is delivering water. Two of these indicators are used on two pumps having a discharge capacity of 1,000 gal. per min. each, and two are used on two pumps having discharge capacities of 2,000 gal. per min. each.

Cast-iron pipe studies

An investigation of the strength of cast-iron pipe and fittings, which has been in progress in the laboratory for several years, is sponsored by Committee A-21 of the American Standards Association. Tests have been made on full lengths of 12-in., 20-in., and 48-in. pit-cast pipe of various makes. The principal object was to study the resistance of the pipe to bursting pressure, flexure and impact. In addition to the full-size tests, many small specimens were cut from the pipe and tested, to determine various strength properties. Tests to failure of a large number and variety of 6- and 12-in. pipe fittings have also been made. It is expected that the foregoing tests will lead to a rational method of designing pipe barrels as well as a new specification for both cast-iron pipe and fittings. Progress reports have been made only to Committee A-21, and the material is not yet available for general distribution.

Split-beam connections

The stress distribution among the rivets of split-H end connections of the type used on the wind girders of tall buildings is being determined experimentally. Various types of connections with one and two rows of rivets on each side of the web of the split-H are being investigated. This investigation has shown that, when there are two rows of rivets on each side of the web of the split--H section, the rivets in the outer rows carry considerably less tensile stress than the rivets in the inner rows and that, in all of the rows of rivets of a split-H section riveted to a column, the tensile stresses in the rivets at the ends of the rows are considerably less than those in the intermediate rivets.

Floodflows on Illinois streams

The purpose of this study is to determine the frequency of floodflows of given magnitudes on 24 Illinois streams. The data used are the daily discharges that have been determined by the U. S. Geological Survey. The first gaging stations were established in 1908. In this study, records of from 10 to 26 years are used, most of them being over 20 years in length. Although it is realized that future records may cause some modification in the results, the present results can now be used for estimating the floodflows from any watershed in the state, and should be of value to engineers in designing bridges, culverts, spillways, drainage ditches, levees or any structures that involve the size of waterway opening.

Garbage and sewage plants

In the field of sanitary engineering the principal problem that is being studied has to do with the domestic and municipal disposal of garbage. A trend has been noted in the home disposal of garbage, to discharge small quantities into the plumbing system. This tendency has been accentuated by the promotion of home "waste-food grinders" designed for the disposal of garbage into the house plumbing system or sewer. In municipal practice some cities have set up garbage-grinding plants for the purpose of preparing garbage for disposal into the sewers.

The discharge of garbage into sewers creates two major problems: (1) the clogging of the pipes, and (2) the overloading of the treatment plant. A few tests have been made of the effect of domestic food choppers on garbage discharged into plumbing pipes. More extensive tests on this problem are contemplated. The power of water to carry garbage will also be studied.

Other data in connection with the digestion of various types of organic wastes are being collected in addition to that collected by the principal observations on the effect of garbage on the operation of a sewage-treatment plant. These data include the composition of garbage, the generation of gas in garbage digestion, the amount of heat and power available from digesting garbage, and the control of odors in the biological disposal of garbage.

Highway traffic studies

A traffic survey is being conducted in Champaign-Urbana, to determine the probable traffic that would use belt lines connecting the state highway entering the cities. From the data recorded it is possible to determine: (*a*) the number of vehicles which pass directly through without stops and therefore are potential users of belt lines; (*b*) the routes used; (*c*) the number of vehicles that make the cities their destination; and (*d*) the number and duration of other stops made. The efficiency, accuracy, reliability and cost of the survey method are being studied.

Another study concerns the visibility and efficiency of highway signs of various sizes, colors, shapes, symbols and wordings, including plain and reflectorized signs. Consideration is given to the visibility of signs to partially color-blind persons.

The efficiency and economics of city traffic control are being studied. This covers the free crossing, the boulevard stop and the traffic signal. Tests are being made to determine the amount of fuel used by automobiles while making stops and starts, from which an estimate of the cost of the various types of traffic control to the traveling public may be made. A fourth study covers highway traffic accidents with reference to the hazard-producing features of roads.

Granular material and other tests

An investigation of the laws of flow through orifices and the pressures due to granular materials in deep bins has been under way for the past few months. The effects of the head, size of orifice and its position are being studied as well as the pressures on the sides and bottom of the bins.

Other subjects under investigation include a study of thermal stresses due to welding, the study of stress at sharp corners by the plaster-model method, joint materials for sewer pipe, joint fillers for brick pavement, reinforced-brick masonry beams, volume changes in burned-clay aggregate concrete, discharge coefficients for pipe orifices under pulsating flow and for orifices in a pipe wall, and various minor projects in fatigue of metals. In addition, there are many allied research projects in mechanical, electrical, railway, ceramic and chemical engineering.

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Important Railway Extensions Built in China

Through lines of travel being created by connecting up existing railway lines—Car ferries used at major river crossings

IN THE DEVELOPMENT of its railway system the national government of the Republic of China is linking and extending existing lines to complete through routes between important cities and districts, as well as extending new lines into the more remote parts of the country, all in accordance with a definite program. During 1934 six projects were under construction, particulars of which have been furnished through T. C. Yen, of the engineering department in the Ministry of Railways. A seventh important feature of the railway development in 1934 was the installation of car-ferry steamers on the Yangtse Kiang, between Pukow and Nanking, thus enabling through trains or through sleeping cars to be run between Peiping, Nanking and Shanghai. Another car-ferry service is to be operated later on the same river between Hankow and Wuchang, as a link in the long direct-rail route between Canton and Peiping, about 1,400 miles.

From the present information as to railway activities and the previous outline of highway development (*ENR*, Oct. 4, 1934, p. 433) it is evident that in spite of banditry, financial difficulties and internal troubles, the Chinese government is steadily extending the lines of internal communication that are so badly needed in that country.

Construction under way

1. Canton-Hankow Railway — The Chuchow-Lochang section, 230 miles, now under construction to close the gap between the existing north and south sections of this 650-mile line, was begun in 1931, but was then interrupted by financial and other difficulties. In 1933, however, arrangements were made to push the work actively under H. H. Ling as chief engineer of construction. In following the gorge of the North River there will be several tunnels and much heavy grading with about 60 per cent of the distance on curves. In some cases the compressors and other plant are mounted on river boats, as access by land is difficult.

The program provides for completion of this link by December, 1936, at a cost of about $59,688,000 (Chinese). With this railway completed and the establishment of the car-ferry noted above, there will be through rail communication from Hong Kong and Canton in the south to Peiping and various points in north China.

2. Lung-Hai Railway — The Tungkwan-Sian section, now being built, is an 82-mile extension of this east and west line to Sian, about 500 miles from the east coast port of Haichow. The railway is intended to reach Lanchow, some 200 miles west of Sian. This present extension, begun in 1930, was completed in December, 1934, at a cost of about $15,000,000.

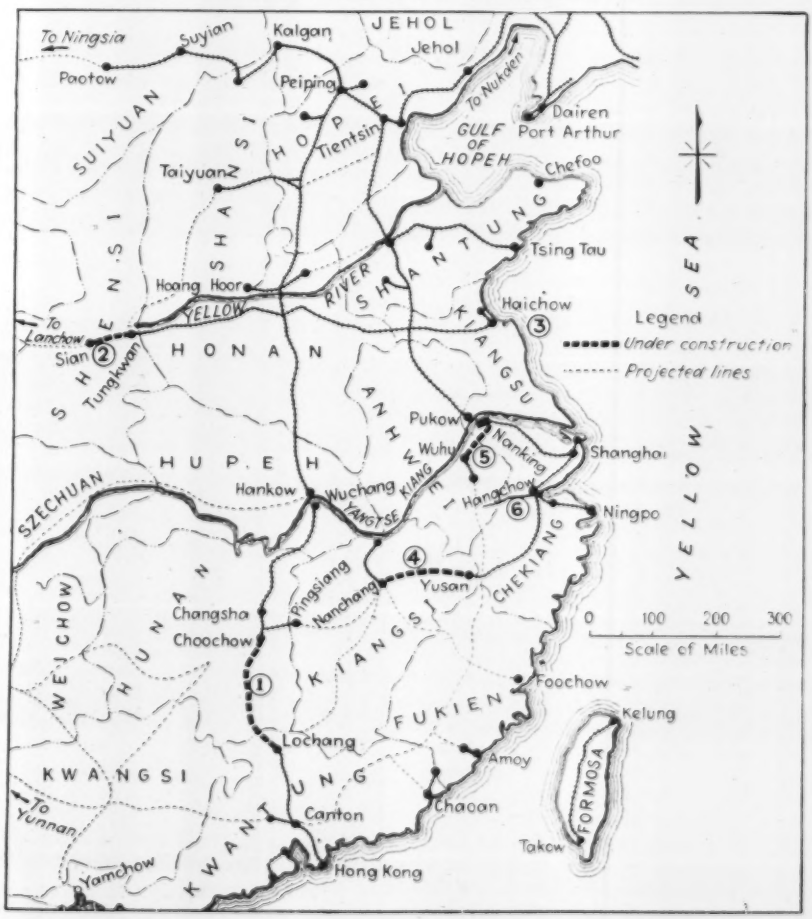
3. Haichow Harbor — Harbor improvements and a new railway wharf at Haichow, the eastern terminal of the Lung-Hai Railway, begun in 1933, were completed in December, 1934, at a cost of about $3,000,000.

4. Chekiang-Kiangsi Railway — Construction is now in progress on the extension from Yushan to Nanchang, 186 miles. The first part of this railway was built from Hangchow to Kiangshan by the government of the province of Chekiang (*ENR*, March 24, 1932, p. 427), and later its extension beyond this province was undertaken by the national government. Its present terminal is at Yushan, 230 miles from the port of Hangchow, and the program provides for its extension eventually to connect with the Canton-Hankow railway at Changsha. The Nanchang extension was begun in July, 1934, and is to be completed by December, 1935, at an estimated cost of $16,000,000.

5. Nanking-Chaoan Railway — Work on the 56-mile Wuhu-Nanking extension of this eastern line, bringing the first completed section into Nanking, was begun in August, 1934, and was completed early this year. Its estimated cost is $5,000,000.

6. Chien-Tang-Kiang Bridge — This river bridge at Hangchow with its approaches, nearly a mile in length altogether, will link up the Shanghai-Hangchow-Ningpo railway with its line into the city of Ningpo. It will be used also by the Chekiang-Kiangsi railway, already mentioned, for through connection with Shanghai and Nanking. It is to be completed by December, 1936, and its cost of about $5,000,000 will be divided equally between the national and the Chekiang provincial government.

RAILWAY CONSTRUCTION in China is concentrated chiefly on connections between existing lines along major routes of through travel.



Soft Ground and Lining Work on the Owyhee Project Tunnels

Geological conditions on longest bore driven by Bureau of Reclamation resulted in need for careful unwatering, advance grouting and steel-plate lining

THE LONGEST TUNNEL driven by the Bureau of Reclamation and one which provided unusually severe soft-ground problems in driving was the 4¼-mile bore on the Owyhee project in southeastern Oregon, to convey water stored by the Owyhee Dam to the project's distribution system. In the outlet half of this tunnel (No. 5) the method used to handle the soft heavy ground, which included serious flows of water and sand at the face, was an outstanding feature of the construction operations, while the inlet half of the same tunnel through good ground provided some progress records of note. At the same time this tunnel was under way, a 3½-mile companion tunnel (No. 1) was being driven as the initial outlet unit from the reservoir. These two constitute the major tunneling work on the Owyhee project, and their driving and lining are described briefly here.

The Owyhee project is being built by the Bureau of Reclamation to provide a supplemental irrigation supply to about 50,000 acres of land and an additional distribution system, which ultimately will convey water to some 70,000 acres of raw land. The most spectacular feature of the project was the Owyhee Dam, completed in the spring of 1933, which will provide 740,000 acre-ft. of live storage. The design of this 405-ft. arched-gravity dam was described in *ENR*, April 26, 1928, p. 883, and the methods of construction were described in *ENR*, Jan. 29, 1931, p. 178. Incidentally the contraction joints were grouted by the bureau when the temperature of the dam reached mean annual temperature (52 deg.) in the spring of 1934, sixteen months after completion of the contract.

Tunnel No. 1 (Fig. 1) taps the reservoir 85 ft. below the high-water level and at a distance of about one-half mile upstream from the dam. This 16-ft., 7-in., horseshoe-shaped tunnel, with a gradient of .000684 and a capacity of 1,840-sec. ft., discharges the main irrigation supply, which is immediately divided into the main North Canal and the South Canal. The North Canal consists of a system of earth ditches, flumes and siphons which is now practically completed down to the 4½-mile siphon crossing the Malheur River—contract for which has been awarded. The South Canal starts out with the 4¼-mile tunnel (No. 5) followed by a ditch section that has not been started. These two long tunnels, No. 1 and No. 5, were driven during the construction period on the dam and are now complete and ready for service.

The driving and lining of the tunnels, exclusive of the inlet and outlet structures, which were let separately, were divided into three contracts. The inlet half of tunnel No. 1 constituted the first contract; the outlet end of tunnel No. 1 and the inlet half of tunnel No. 5, which could be worked conveniently from a common point of approach, constituted a second contract unit; and the outlet half of tunnel No. 5 was covered in a third contract. As a result of this arrangement, the two halves of each tunnel were being driven concurrently by two different contracting organizations.

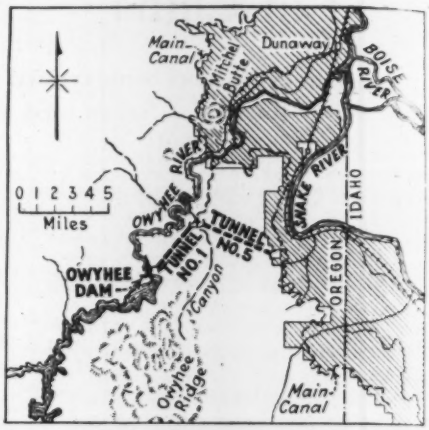


FIG. 1—SKETCH MAP, showing relative positions of tunnels No. 1 and No. 5 to Owyhee reservoir and main canals.

Tunnel No. 1, inlet end

Geology—As the geologists had predicted, the rock formation traversed by tunnel No. 1 consisted principally of tuffaceous conglomerate, basalt and red cinder rock. The latter material was dense and self-supporting, the others were seamy in places, with blocky areas requiring timbering as driving progressed. Both the cinder rock and the tuff are characterized as "dead" rock and have little tendency to fly when shot during the driving process. The tuff is broken by cleavage planes along the lines of sedimentation, and the basalt encountered in the main section of the tunnel contains numerous faults and dikes at a location about one-half mile from the intake portal. However, no serious pressure developed during driving if the ground was caught up in time. About 40 per cent of the footage on the outlet end and 44 per cent on the inlet end of tunnel No. 1 were timbered with 10x10-in. Douglas fir sets prior to the placing of the permanent concrete lining.

Driving Procedure—After driving the first 3,600 ft. of the inlet portal by a 10-ft. bench heading, the remaining distance to the mid-point, at the end of the contract, was advanced with a full face.

FIG. 2—TIMBERING in the inlet end of tunnel No. 1, with concrete lining shown in the background.

The top holes for each round were drilled from a platform suspended from drill steel driven into the side walls.

The usual drilling plan consisted of 43 holes from 9 to 11 ft. in length to pull an 8-ft. round. Powder requirements averaged 2.9 lb. per cubic yard of pay excavation. An electric circuit of 440 volts with locked switchbox was used for firing. Overbreak ran about 10 per cent of pay excavation, or about 40 per cent of concrete pay yardage. The driving cycle averaged from six to ten hours, subdivided about as follows: drilling and firing, 2 to 5 hours, ventilating about 15 minutes, and mucking 3 to 5 hours.

After using a small air shovel for loading rock at the face with only moderate success, electric mucking machines were used for the remainder of the job. The machine averaged about 4 hours in loading a round of 100 cu.yd. of broken rock. Loading procedure followed the usual practice of using an air-lift car switcher behind the face, to transfer empty cars as they were handled by the train behind the mucker.

Tunnel No. 1, outlet end

At the outlet end of the tunnel, although the details of drilling and handling material differed slightly as a result of the operations under another organization, the general rock conditions and procedure were the same. Each round consisted of 42 holes, averaging about 9 ft. in depth and loaded with 25 lb. of powder. The time for each round varied from six to ten hours.

The entire tunnel was driven practically dry, with the exception of one flow of about 30 gal. per minute, which was encountered ½ mile in from the inlet portal. Progress made on this half ran as high as 44 ft. in 24 hours, with a maximum month of 700 lin.-ft.

Concrete lining (No. 1)

Concrete lining averaged, in general, 1-in. thickness for each foot of tunnel diameter, and no rock or timber was permitted nearer than 8 in. to the neat line. Excavation more than 6 in. beyond the average line was not used in calculating pay for lining concrete. The lining was not reinforced except at portals and transitions.

The method of placing concrete lining was optional with the contractor, according to specification, provided steel forms were used and the concrete conformed to stipulated quality requirements. It is of interest to note the different methods used by the two contractors in lining No. 1 tunnel.

At the inlet end of the tunnel the arch section was placed first in 60-ft. sections, followed at a distance of about 1,000 ft. by the screeded invert section placed in 20-ft. lengths for the full width of the tunnel. The average daily progress of a 60-ft. section of arch and a 100-ft. length of invert in eight hours required form moving about every 48 to 72 hours.

Transit mixers of 3-yd. capacity, gasoline-operated, were filled at the overhead batching plant at the portal and hauled into the tunnel at a rate of about 10 miles per hour by gasoline locomotive. The mix was unloaded onto an endless belt conveyor, which fed into a 1-cu.yd. pneumatic concrete gun discharging into the top of the forms through an 8-in. pipe.

A separate jumbo carried the forms, the gun and the pipe, permitting the discharge to be directed along the top of the form to facilitate distribution in horizontal layers rather than on a slope that would cause segregation as the concrete flowed laterally.

FIG. 3—HEADING IN ROCK on the outlet end of tunnel No. 1, with mucking machine in position.

The contractor on the outlet end of the tunnel elected to place the invert first, followed by the arch section. The steel forms for the arch were moved ahead by jumbo, wedged into position and anchored at the base by bolts left in the concrete at 4-ft. intervals. In placing the invert, alternate 20-ft. lengths were concreted first on one-half the tunnel width, and 48 hours later the intervening alternate blocks were poured, using the finished sections as guides for screeding. The tracks were then transferred to the completed half, and the other side of the invert was placed in alternate blocks to a height about 2 ft. above bottom grade.

By placing the invert first, a better construction joint was attained, settlement of the arch form was eliminated, and speed in lining was less affected by the time limit required for the arch form to remain in position. However, it was necessary to clean up the grout that dripped from the arch on the finished invert and to rehandle the track. Moving of the track was usually necessary anyway in the invert trimming.

The steel arch forms were made in 10-ft. sections of ⅜-in. plates, and seven of these panels were moved ahead by a traveling jumbo for one pour. The time of removal was governed by the thickness of the lining, condition of the concrete, and the tunnel temperature, which varied from 36 to 72 deg. F. Four hours were required for moving forms, and ten hours was necessary for placing concrete in the 70-ft. section. A maximum of 120 lin.-ft. of invert was placed in an eight-hour shift, 200 ft. in 24 hours, 3,490 ft. in a month.

Batching and Mixing—The contractor on the outlet end of this tunnel, who also had the contract for the inlet half of tunnel No. 5, set up a modern batching plant handling bulk cement where it could be used in lining both tunnels. The sand and two grades of coarse aggregate up to a maximum of 1½ in. were proportioned by weight. The cost of the graded materials at this handling plant was $1.25 per cu.yd. and $1.50 at the mixers, with cement at $3.20 per barrel.

A concrete mix of 1:2:2½:2½ by weight was used with a slump of about 5 in. The water-cement ratio was 0.9, and the average compressive strength in 28 days was 3,200 lb. With a reduction in the water-cement ratio to about 0.8, the strength was increased to 4,000 lb.

For three-shift lining operations, the crew consisted of about 80 men for both inside and outside work.

Air for the outlet end of tunnel No. 1 and the inlet end of tunnel No. 5 was provided by a common plant equipped with two blowers of 4,000-cu.ft. capacity each. These blowers supplied air at 4 lb. pressure, and each was driven by a 100-hp. motor. On the inlet end of tunnel No. 1 a blower driven by an 85-hp. motor was used for ventilation, and on

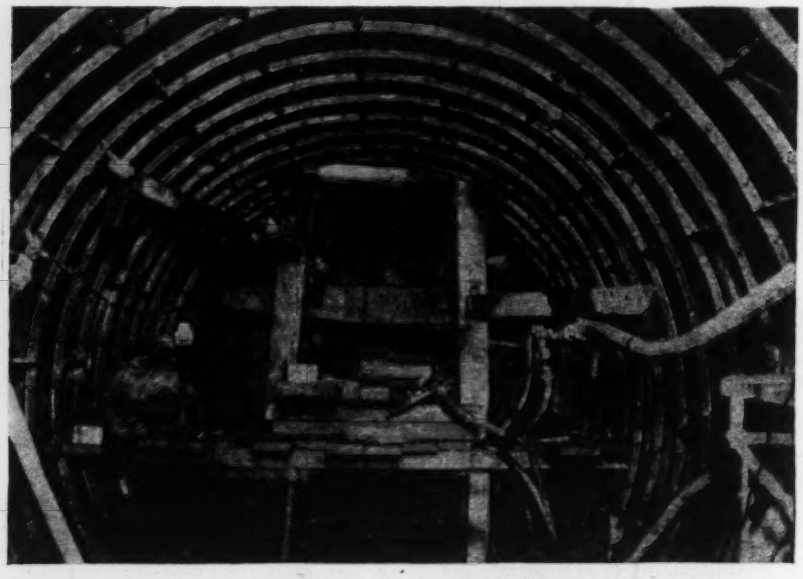


FIG. 4—RUNNING GROUND, bulkhead and flowing water, typical of conditions on the outlet end of tunnel No. 5, where steel liner plates were used extensively.

the outlet end of tunnel No. 5 a fan driven by a 40-hp. motor was used at the portal with a booster fan nearer the heading.

The 8- and 14-ton gasoline locomotives that the contractors used for hauling in the tunnel placed a heavy demand on the ventilation system. To protect workmen against carbon monoxide hazards, experts of the U. S. Bureau of Mines were invited to make tests of conditions and recommend safety measures. As a result of these studies, the minimum fresh-air requirement was placed at 5,000 cu.ft. per min. per heading, provided the tunnel was cleared once every 24 hours. With the increased equipment to provide for this requirement, satisfactory air conditions were maintained, although the air was foul, but not dangerous during periods of heavy hauling. The maximum rock temperature was about 80 deg. F.

Tunnel No. 5, inlet end

Driving to an 11-ft. rough diameter through basalt and red cinder rock, the contractor on the inlet end advanced on this 10,966-ft. section, making rapid progress and establishing a record of 1,157 ft. in a 31-day period, working partly on a two-shift and partly on a three-shift basis. During one 79-shift period a length of 1,315 ft. was driven, and at another time, 1,562 ft. was driven in 93 shifts. The one-day record was 63 ft., which had been preceded by a 56-ft. day and was followed by a 50-ft. day. During this time about 250 ft. of tunnel was also being widened for a siding.

For the entire inlet half of tunnel No. 5, excavation proceeded with remarkable consistency. The entire distance of 10,966 ft. from portal to midpoint was driven in twelve months.

The drilling of twenty holes, 9 ft. deep, with wet drifter drills, loading with 5.3 lb. of 40 per cent powder per pay-yard and firing occupied about a two-hour period. Ventilation was reversed for about 15 min., and mucking took from one to two hours.

Lining—The inlet end of tunnel No. 5 was concreted before the work of lining started on the outlet end of No. 1. The same mixing plant and placing equipment were used, with special jumbos to handle the 360 lin.-ft. of steel forms and placing pipe.

In this heading the arch was poured first in 60-ft. sections, preceded by the placing of concrete or timber curbs to support the forms. After about 1,600 ft. of arch had been placed, the invert was cleaned, concrete placed and screeded by hand. Progress averaged about 100 ft. of arch section in twelve hours, with a maximum of 290 ft. placed in a 24-hour period. Placing often ran as high as 200 cu.yd. in eight hours. Invert progress reached a maximum of 300 ft. in sixteen hours—3,610 ft. in a month.

The outstanding feature of the entire tunneling program was the struggle with heavy running ground in the outlet half of tunnel No. 5 and the methods of grouting and lining used to solve the problem. The seriousness of the condition is indicated by the fact that, of the 10,980 ft. driven under this contract, 6,640 ft. had to be held with steel liner plates prior to the placing of the concrete lining, in contrast to the condition on the inlet half of the tunnel, which required only 804 lin.-ft. of light timbering through the entire 2⅛ miles traversed.

From the outlet portal to a point about 3,300 ft. inside, the tuff, basalt and red cinder rock proved self-supporting. In this section an inflow of water that reached a volume of 700 gal. per min. (later dwindling to 100 gal. per min.) was passed without particular difficulty.

As the work advanced beyond the 3,300-ft. mark, within the next thousand feet the ground changed to a talc formation that was heavy with moisture. This material required heavier timbering, which was finally increased to 12x12-in. Douglas fir, full sets on 2-ft. centers. Finally, at a distance of 4,370 ft. in from the portal an inflow of sand and water occurred, which deposited muck for a distance of 60 ft. back from the heading. A timber bulkhead was constructed, and no advance was made beyond this point for a 90-day period. For 30 days work was shut down completely, to see if the water would drain and reduce the pressure on the bulkhead.

Following unsuccessful attempts to drain out the water through 3-in. pipe and to accomplish any advance by means of a top heading or bottom drift, the problem was finally solved by the use of steel liner plates in combination with high-pressure grouting, which cut off the water sufficiently to permit excavation to advance one ring at a time.

To provide a solid anchorage for the start of the steel lining operations, the first ring of twelve ⅜x16x36-in. plates was set 43 ft. back from the last timber set, which had failed at the heading. The liner plates formed an 11-ft. 6-in. diameter circle. As this lining advanced, one ring at a time, the work was seriously hampered by the mass of tangled 45-lb. rail that had been used for spiling and had later bent down under the pressure of the ground when the timbers failed. When the work had been advanced to the bulkhead, it was drilled with air augers, but the periodic gushes of water, air and sand (Fig. 4) spouting out through these small openings seriously interfered with this work.

Advance Exploration—As a result of these conditions, the decision was reached to explore ahead of the bulkhead by means of electrical-resistivity prospecting methods, to determine the character of the ground in advance and on both sides of the heading. This work was done to determine the feasibility of detouring from the established alignment, to avoid the water.

The exploration indicated much better rock about 500 ft. ahead, 450 ft. on one side and about 1,000 ft. on the other side. This condition left no alternative other than to proceed straight ahead on the established line.

The next step was to drill three diamond-drill holes about 130 ft. long for the combined purpose of prospecting, drainage and grouting. One of these holes was drilled ahead along the center line, one was inclined 30 deg. to the left, and the other 30 deg. to the right. These holes encountered shale, soapstone and talc as well as several water-bearing seams in which the pressure dropped from 60 to 25 lb. after the holes had been opened up.

While the water at the heading was

draining out through the long holes, short holes were drilled and grouted under 250-lb. pressure, so that the work of excavating and placing liner plates could proceed. During the grouting process it was necessary to reinforce the steel lining heavily with struts and jacks. The general procedure was to drill one of these grout holes until water was encountered (up to a maximum depth of 18 ft.) and then immediately apply the grout to this hole.

After the entire heading had been drilled and the water seams grouted off, the regular work of excavation and placing of liner plates followed until more water was encountered. Altogether more than 7,000 cu.ft. of grout was required in going through the 190 ft. of water-bearing rock.

In going through the heaviest ground, ⅞-in. liner plates were required in place of the ⅞-in. thickness of plates used at the start. As the pressures decreased, ¾-in. and then ⅞-in. plates were again used. Finally, for a distance of about 700 ft., skeleton rings, with some of the plates omitted, were found adequate and resulted in considerable economy. However, because of the tendency of the material to slack upon exposure, it was considered advisable and necessary to line all of the remaining distance to the mid-point with steel plates.

Three shifts of about twenty men each could excavate and line from 12 to 22 ft. of tunnel per day, allowing about one hour for drilling and shooting the soft rock, four hours for mucking and three hours for installing rings and packing.

The driving of the outlet end, fortunately, was on an upgrade. The end of the completed inlet half of the tunnel, which had been finished several months ahead, had accumulated about 1,300,000 gal. of water by the time the outlet end reached the center. The holing through of the heading, to complete the connection, required the draining out of this water. A 2½-in. diamond-drill hole was drilled from the advancing face to tap this water, which drained out in a period of about eleven days. The tunnel was then completed and the connection was made without further trouble.

The lining of the lower half of tunnel No. 5 was done from the upstream portal by dry-batching through the existing plant used by the other contractor and transporting the dry material through the inlet end of the tunnel to a conveyor belt, which fed a 1-yd. mixer mounted above a plunger-type concrete gun for placing.

The invert section was placed first beginning at the outlet portal, and completed for the entire distance before work was started on the arch section. A crew of about 50 men constituted the force for lining with a two-shift operation. During March, 1933, some 5,025 ft. of invert was placed, and in April 5,406 ft. of arch lining was placed.

Organization—The Owyhee project is being contracted by the Bureau of Reclamation, Elwood Mead, Commissioner, and R. F. Walter chief engineer. F. A. Banks was construction engineer from the start of the work until succeeded by R. J. Newell in August, 1933. F. Schlapkohl is field engineer, and C. A. Betts office engineer.

Contract for the inlet end of tunnel No. 1 (9,350 ft.) was held by T. E. Connolly Co., Wm. Connolly superintendent. The outlet end of tunnel No. 1 (9,375 ft.) and the inlet end of tunnel No. 5 (10,966 ft.) were built by J. F. Shea Co., Morton Boss and later Gilbert Shea, superintendent. Contract for the outlet half of tunnel No. 5 was held by S. S. Magoffin Co., Frank Purvis superintendent.

Sewage-Plant Survey—XIII

Data from Worcester, Mass.

THE FOLLOWING ARTICLE is the thirteenth of a series presenting in brief form the salient design and performance characteristics of American sewage plants. Articles already published have presented data from the following cities: Decatur, Ill.; Cleveland, Ohio; Schenectady, N. Y.; Aurora, Ill.; Lima, Ohio; Grand Rapids, Mich.; Urbana, Ill.; Baltimore, Md.; Toledo, Ohio; Akron, Ohio; Rockford, Ill.; and Allentown, Pa.

DURING 1933 the sewage-treatment plant at Worcester, Mass., removed 89 per cent of the B.O.D. and 77 per cent of the suspended solids from the city's sewage before discharging it into the Blackstone River. Detailed design and performance data for the year are given below.

Worcester's sewage plant comprises coarse screens, grit chambers, Imhoff tanks, trickling filters and secondary settling tanks. The plant was designed by the superintendent of sewers and the city engineering department to care for a population of 242,000, predicted for 1934. The plant was put into operation in June, 1925. Its total cost to date is estimated to be about $4,300,000.

The sewerage system in Worcester is 36 per cent on the combined plan and 64 per cent separate. During the year reported, the sewage flow was abnormally low in volume, although of about normal strength. The low flow can be attributed to the decreased quantity of industrial-waste liquors received.

Analytical results presented in the following table are based on a 24-hour composite sample. Sewage flows are measured by venturi meters and by cycle counters on the dosing tanks.

These data have been made available by Roy S. Lanphear, supervising chemist, in charge of the sewage-treatment plant. J. H. Brooks, Jr., is superintendent of the city sewer department.

SEWAGE-PLANT PERFORMANCE DATA, WORCESTER, MASS.

GENERAL DATA

Population, 1933	195,000
Population served, 1933	187,000
Rated capacity of plant, m.g.d.	28
Sewage flow	
Average m.g.d.	19.7
Maximum day, m.g.d.	53.7

SEWAGE-TREATMENT UNITS

Coarse Screens

Number of units	2
Width of opening, in.	1½
Angle of screen with horizontal, degrees	45
Method of cleaning	Mechanical rakes

Grit Chambers

Number of units	2
Plan dimensions, each unit, ft.	75x8
Operating depth including grit space, ft.	8½–10
Depth allotted to grit space, ft.	2½–4
Average flow, each unit, m.g.d.	10.5–11.0
Detention period at actual flow, each unit, min.	1.2
Method of cleaning	Flushing with sewage
Frequency of cleaning	monthly

Imhoff Tanks

Number of units	12
Plan dimensions, each unit, ft.	61x90
Settling compartment	
Surface area, each unit, sq.ft.	4,050
Depth to slot, ft.	12
Sludge compart., each unit, cu.ft.	51,300
Gas-vent area each unit, sq.ft.	1,100
Sewage flow all units, m.g.d.	19.5
Detention period all units (actual flow) hours	2.9
Frequency of sludge removal each unit times per year	18

Trickling Filters

Number of units	4
Plan dimensions each unit, ft.	198x752
Sewage flow, all units m.g.d.	18.9
Type of filter material	granite, trap rock
Depth of filter material, ft.	10
Type of distributing system	spray nozzle

Secondary Sedimentation Tanks

Number of units	4
Plan dimensions, each unit, ft.	69x120
Operating depth, including sludge space, ft.	15
Depth allotted to sludge space, ft.	7
Sewage flow, all units, m.g.d.	18.9
Detention period at actual flow, both units, hr.	2.2

ANALYTICAL RESULTS

	Settleable Solids, c.c. per liter (2 hr.)	Suspended Solids, p.p.m.	Five-day B.O.D. p.p.m.
Screened sewage	6.4	224	214
Imhoff tank effluent	0.8	97	140
Trickling-filter effluent	3.0	118	34
Secondary-tank effluent	1.0	53	24

SCREENINGS, GRIT AND SLUDGE

	Volume, Cu.Ft. Per M.G.	Dry Solids, Per Cent	Volatile Solids, Per Cent	pH	Disposal
Coarse screenings	2.7				Incineration
Grit	4.1	26–63[1]	30–65[1]	...	Fill
Imhoff-tank sludge	227	6.9	49.8	6.8	To drying beds

Note: [1]Inlet—outlet.

Richmond Completes Interesting Program of Bridge Construction

Five new concrete bridges built and one steel viaduct remodeled under an RFC loan conditioned on a toll-repayment basis—Rigid frames, multiple arches and concrete bowstrings features of design—Varied construction by contract, CWA and relief forces

FIG. 1—A BEAUTIFUL MULTIPLE-ARCH CONCRETE BRIDGE over the James River is the feature of a six-bridge program recently completed at Richmond, Va. Five of the structures are visible in this air view; the sixth, the First Ave. Viaduct, lies outside the upper left corner.

COMPLICATED skewed bowstring arches of reinforced concrete built over busy railroad tracks by relief labor, a magnificent multiple-arch concrete bridge spanning the historic James River at high level, two rigid-frame concrete viaducts replacing old steel trestles over deep Shockoe Valley, and the strengthening of a long steel viaduct are features of an extensive bridge program just completed by the city of Richmond, Va. The entire program is unique and of unusual interest in financing, design and construction. Financing was by an RFC loan. Construction methods ranged from the primitive handling of concrete in 12-qt. buckets to ingenious arrangements for forms and concreting by a modern plant on the contract section of the river bridge.

Traffic in and through Richmond has long been hampered by inadequate arteries radiating from the central business district, which is hemmed in on one side by the James River and on two other sides by a deep valley. From the north, the only access was by two old narrow trestles across Shockoe Valley at First and Fifth Sts., owned by the local power company operating the street car system and open to vehicular traffic on a toll basis. The main outlet to the east was another inadequate toll bridge at Marshall St., also owned by the power company. On the south side of the business district is the river, crossed by two old, narrow, low-level structures with tortuous approaches through steep narrow streets.

With unemployment seriously increasing in the fall of 1932, the city developed a plan of relieving the growing relief load by the construction of the badly needed traffic arteries radiating from the business center. At the suggestion of State Senator John J. Wicker, Jr., the Richmond Bridge Corp. was formed as a public agency to apply for an RFC loan. The firms of Allen J. Saville, Inc., and Lee, Smith & Van Dervoort, Inc., of Richmond, were selected to do the engineering work, with A. C. Janni of New York retained as consulting engineer. Actual work started on the First and Fifth Sts. viaducts late in 1932, although it was not until the following spring that the bridge corporation was officially created and a loan of $1,700,000 was definitely secured.

Comprehensive plan

The plan was extended to provide for five new bridges and the repair of a sixth (Fig. 2). The First, Fifth and Marshall St. viaducts were purchased from the power company. The first two were replaced entirely with unusual rigid-frame concrete viaducts. At Marshall St. extensive repairs and alterations widened and strengthened the old steel-truss structure. A high-level multiple-arch concrete bridge was designed for the river crossing, connecting Belvidere St. in Richmond with Cowardin Ave. in south Richmond. To provide proper and adequate approaches to the James River Bridge, Second St. on the Richmond side was extended across the C.&O. freight yards on a two-span parabolic tied-arch bridge, to connect with the north plaza; on the opposite side of the river a new single-span bowstring arch was built to carry the main

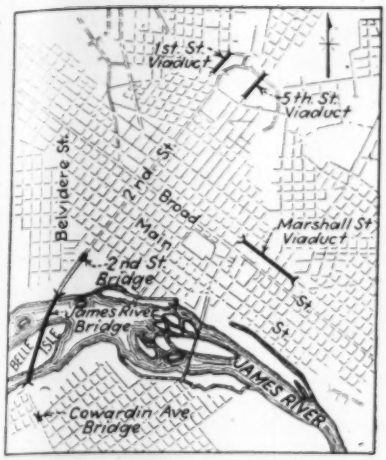


FIG. 2—RICHMOND'S new bridges provide ready access to and from the business district, and also carry through-traffic around congested areas, as this map of the central part of the city shows.

Cowardin Ave. approach over the A.C.L. Railway tracks.

To amortize the RFC loan, the four large structures—James River, Marshall St., First St. and Fifth St. bridges—are made toll projects, to become free when the loan is repaid. There was no practical way to charge toll on the short Second St. and Cowardin Ave. bridges; also most of the traffic using these structures will continue over the river bridge, where it will have to pay toll.

Relief labor

Relief labor was extensively used in the new bridge program. At the start of work on the First and Fifth St. viaducts, relief labor was used exclusively, equipment rental and materials being paid for out of the RFC loan. After 40 per cent of the work on the two structures had been completed, the system of operations was changed to a straight force-account basis under the direction of the bridge corporation, will all expenses met from the loan fund. This method of operation still lacked the speed required to finish these two bridges in desired time. To speed up the work, the last 30 per cent was performed by contract. Relief labor was used in building the north approach of the river bridge, a complicated structure crossing railroad tracks and a canal. The remainder of the river bridge, including all of the arch spans, was built under a single contract, though the contractor was required to use labor from relief lists whenever possible. On the Cowardin Ave. and Second St. bowstring arches, relief labor was used exclusively throughout, with materials and equipment rental paid for out of the loan. In the course of construction of these two bridges, every relief agency devised by the city, state and federal government had a hand in construction at some time or other. Municipal and state agencies gave way to the CWA for a few months, and SERA and FERA finally finished the job.

Unusual designs

All of the new structures are of outstanding interest in design with expansion provisions as a predominating feature.

First and Fifth St. Viaducts—Except for length, the two Shockoe Valley viaducts are identical in design. The First St. bridge is 876 ft. 8 in. in length, made up of eight 80-ft. spans and two shorter spans at the ends. At Fifth St. the structure comprises fourteen 80-ft. spans and two abutments, totaling 1,185 ft. overall. The design consists of two concrete deck girders carrying concrete floor beams, floor slab and surfacing, the whole supported on alternate stiff and flexible towers (Figs. 3 and 4). With the main girders spaced 20 ft. apart, the floor-beam system is cantilevered on both sides, to provide a 30-ft. roadway and one 4-ft. sidewalk. A single streetcar line occupies the center of the roadway.

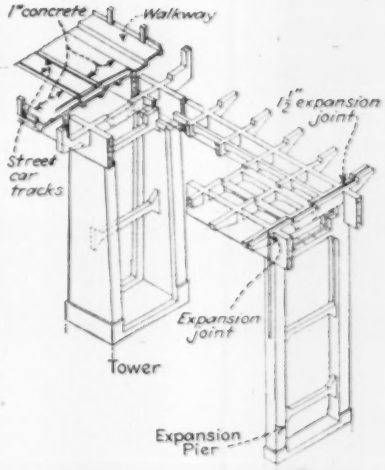


FIG. 4—ISOMETRIC SKETCH of a typical First St. Viaduct span, illustrating the concrete framing.

The stiff towers are channel-shaped columns of concrete braced by cross-struts. These towers form the support of double-span rigid frames, the opposite ends of the girders being carried on thin concrete piers 20 ft. high. Expansion is taken care of by flexing of these piers. Adjacent expansion piers are carried on a common concrete pedestal to rock, braced by cross-struts. Fig. 4 shows this design.

Second St. Tied Arch—The Second St. bridge across the C.&O. Railroad yards consists of two 147½-ft. spans of

FIG. 3—FIRST ST. VIADUCT over the Shockoe Valley, in which slender concrete columns provide for expansion of the structure through bending. The Fifth St. Viaduct over the same valley is of similar design.

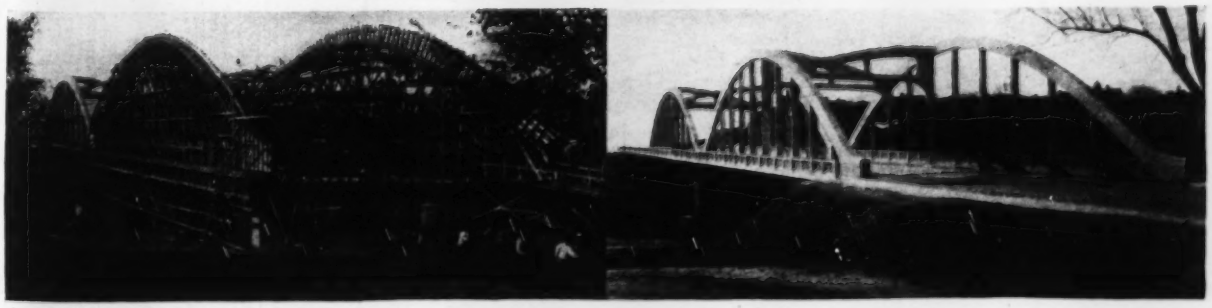


FIG. 5—RELIEF LABOR built the Second St. double-span concrete tied-arch bridge. The heavy timbering and falsework required to construct these complicated concrete structures is indicated by the view at the left. At the right is a view of the completed bridge, showing the large skew that necessitated the unusual portal bracing.

concrete bowstring arches and two rigid-frame deck approach spans, all complicated by a skew of 46 deg. 55 min. The arches are parabolic curves of constant section, 2x3½ ft., tied with bottom chords 2x2½ ft. in section, the arches being spaced 42 ft. apart. Each chord is suspended from the arch by ten 1x2-ft. concrete hangers. A 40-ft. concrete roadway is carried by transverse floor beams spaced 12 ft. 9 in. apart, and a 4-ft. walk is carried by cantilever extensions of the floor beam outside the arch on one side. The 40-ft. clear span of the floor beam required a minimum depth of beam of 4½ ft. at the center. To keep the depth of the bottom chord at a minimum, these floor beams were reduced to 2½ ft. at the ends, and were widened from 2 ft. to 2 ft. 8 in.

An interesting detail of design is the arrangement of the lateral bracing of the arches. Because of the skew, there were only two points at which the arches could be tied together and still clear roadway traffic. At these two points semi-parabolic frames with horizontal bottom chords were installed, as shown in Fig. 5.

Expansion is taken care of by double flexible columns at the center piers of the two arch spans, the end piers of the spans being heavy enough to resist bending. Single expansion columns, capable of resisting the heavy vertical reaction at the ends of the arches, would have been too large to allow bending under elongation thrusts of the bottom chord. This problem was met by splitting the expansion piers in the two narrow columns, permitting easy flexing. The flexible pier principle of expansion was also carried out on the rigid-frame approach spans of this bridge.

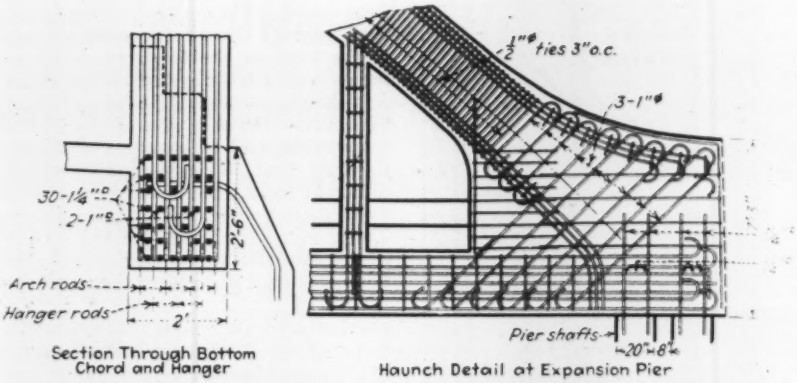


FIG. 6—COMPLICATED REINFORCING at the junction of arch rib and bottom chord on the Second St. Bridge. Close supervision was required to place this steel with inexperienced relief labor.

The roadway is finished with a 2-in. asphalt wearing surface. It is well lighted by lamps carried on brackets on the vertical hangers. Along each side of the bridge is a concrete hand-rail of precast units built into cast-in-place rail members.

Cowardin Ave.—The Cowardin Ave. bridge over the A.C.L. tracks is a single-span tied arch, 190 ft. long. It is somewhat similar in design to the Second St. spans, but differs materially in several respects. The arches, 44½ ft. apart, permit a 40-ft. clear roadway, and a 4-ft. sidewalk is cantilevered out beyond the bottom chord and hangers on each side. This structure is on a skew of 28 deg. 5 min., which complicates the design. Short approaches are of flat-slab design, with fills held by retaining walls.

The axis of each arch rib is a parabola, and the ribs vary in height from 6.36 ft. at the haunches to 5½ ft. at the crown, maintaining a constant width of 2½ ft. At the junction of the arch and bottom chord, the extrados of the arch ribs flattens out to provide a massive solid connection 11 ft. high. Thirteen hangers 1x2 ft. in section carry the bottom chord of each arch.

Portal or lateral bracing is similar to that at Second St., consisting of two semi-parabolic frames with horizontal bottom struts. In addition to the two frames, a 1x4½-ft. transverse strut is set between them. Floor system, roadway and hand-rail details are similar to the Second St. design.

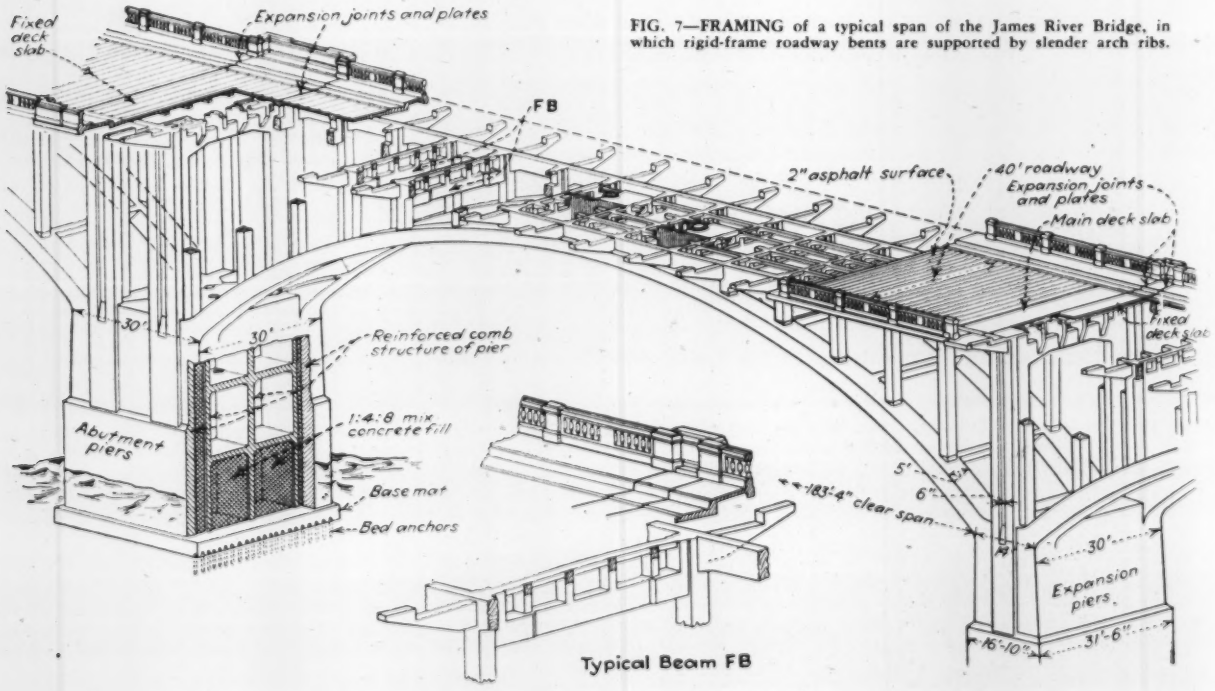


FIG. 7—FRAMING of a typical span of the James River Bridge, in which rigid-frame roadway bents are supported by slender arch ribs.

Flexible piers provide for expansion. One end of each arch rests on a solid 5½-ft. square pier; the other end is carried by three 1½x7-ft. shafts set 6 in. apart. Heavy collision walls protect all four piers. As the expansion piers extend below ground level, a protection shell of 6-in. concrete wall is built around each set to a height well above ground level; this wall is sealed at the top with a bituminous material, to keep dirt from collecting between the shafts and impairing the flexing action.

James River Bridge—The largest unit in the new bridge program is the high-level crossing of James River, consisting of sixteen arches of 183-ft.4-in. clear span, a complicated approach structure at the north end and a simple approach plaza at the opposite end. For construction purposes the arches were divided into three sets separated by abutment piers, capable of taking the unbalanced thrust of arch construction on one side at a time. The bridge crosses over Belle Isle, which splits the river into two channels. Foundations were simple, as in both channels the water is shallow with rock bottom, and rock is found close to the ground surface on the island. One abutment pier is on the island, the other is in the north channel, the foundation mat of the latter being anchored to the ledge by dowels. These abutment piers, 30 ft. square, are hollow, with cross-wall bracing. The lower cells are filled with lean concrete to provide additional weight. The remaining piers are 14x30-ft. hollow shafts set on wider hollow bases, filled to water level. Length of piers and length of span were dictated by site conditions rather than by economics.

Each span consists of two circular arch ribs, spaced 25 ft. apart, 5 ft. wide, with thickness varying from 4 ft. 3 in. at the haunches to 3 ft. at the crown, tied together by eight struts and two transverse floor beams at the crown. The deck is carried by a series of trans-rigid-frame bents, resting on the arch ribs, with cantilever brackets on each bent providing for a 40-ft. roadway and two 4-ft. walks. Expansion of the deck structure is taken care of by flexing of the columns. At the narrow piers a single frame bent carries a fixed roadway section, while at the wider piers two frames carry a fixed section, leaving the deck section over the arches of constant length throughout the bridge (Fig. 7).

A complicated design was required for the north approach spans of the river bridge because of conditions at the site (Fig. 8). On benches cut into the steep river bank there are a three-track railway line of the C.&O., the Kanawha Canal and a double-track C.&O. freight line on a steel trestle, the canal and tracks crossing the bridge center line at various angles of skew. The new Second St. extension intersects the river crossing at the north approach, further complicating the design. As this will be the main approach road from the business section, it was desirable that the on-bound traffic lane be carried under the bridge and up a ramp to the main spans, eliminating crossing off-bound traffic at grade. A ramp on the opposite side of the approach carries traffic from the bridge to Second Ave.

A series of single and double rigid-frame spans constitutes the north approach, with columns and footings placed at random at available points among the tracks and alongside the canal. Some of the footings required precast concrete piles, but most of them could be carried to rock without trouble. Thin flexible columns provide for expansion of the approach spans. At the extreme north end, where the expansion columns are carried deep into the sloping bank to rock, they are completely encased in a protective well of thin concrete walls, sealed at the top to keep the wells clear.

Marshall St. Viaduct—This steel viaduct, 2,456 ft. long and built in 1910, was in poor condition. It was designed as simple deck trusses, but in erection the top chords were made continuous across alternate towers, throwing excessive compressive stresses into them. This resulted not only in buckling of the chord members but also overstressed the tower legs.

In reconstruction, the roadway was widened 3 ft. and each sidewalk was widened 6 in. To reduce the dead load, the concrete walks were replaced by wood planking. The top chords were cut and properly connected, to create true simple spans, and the columns, were strengthened accordingly. A continuous coverplate was welded to the bottom of the longitudinal floor girders that carry the streetcar tracks. The old wood-block paving was replaced with asphalt.

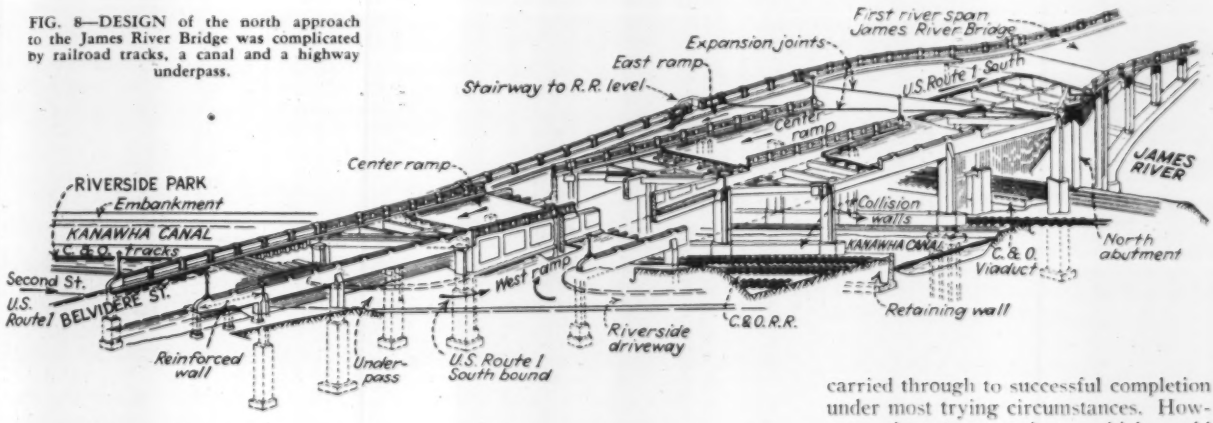
Relief-labor construction

Both of the tied-arch bridges, parts of the James River crossing and the two Shockoe Valley viaducts were built by day-labor methods with inexperienced relief labor. It was a bold undertaking to attempt the difficult construction of the bowstring-arch structures by this method, and it is to the credit of the supervising engineers that the work was carried through to successful completion under most trying circumstances. However, these two projects, which could have been completed within six months by contract, strung out to eighteen months under the relief-labor methods.

The design of the two bridges was enough in itself to create difficult construction problems. Because of the tied-arch design, the entire weight of one span had to be carried on falsework until the last yard of concrete was in place (Fig. 5). The location over railroad tracks added to construction difficulties.

The most serious interference with construction progress was occasioned by the constant uncertainty as to the supply of relief labor. From day to day the supervising engineers had to change construction plans because of a variation in labor supply, which ranged from a minimum of seven men to a maximum of 800. Work started with direct relief labor, sometimes paid for in cash, again in grocery orders. Materials, construction supplies and rental of equipment were provided for from the RFC loan. Later the projects were switched to the CWA organization, and finally were finished up under FERA. Naturally, the restrictions placed upon working time of individuals, limited to a certain number of hours per week or to a maximum earning per week, resulted in a tremen-

FIG. 8—DESIGN of the north approach to the James River Bridge was complicated by railroad tracks, a canal and a highway underpass.



dous labor turnover and precluded efficient planning of work.

A vast amount of timber cribbing and falsework was required for the construction of the tied arches, as can be noted in Fig. 5. Forms were intricate, and their construction along with the placement of the complex network of heavy reinforcing bars by inexperienced labor required unusually close supervision. Forms in general were rough lumber faced with plywood, which was used extensively on all of the bridges.

Very little equipment was used on any of the relief-labor projects. On the Second St. and Cowardin Ave. bridges, concrete was mixed in a 21-E paver, charged by wheelbarrows. The mixed concrete was wheeled over the falsework deck and dumped directly into forms wherever possible. For the arch ribs and portal bracing, concrete was hoisted from deck level in small buckets by a rope running through a pulley hanging from the forms.

FIG. 9—FORMS for one of the Cowardin Avenue arch ribs. Plywood was used extensively as form lining on all of the bridges.

Construction of the parts of the First and Fifth St. viaducts and the north approach of the river bridge done by relief labor was slow but not particularly difficult. Equipment required for the dismantling of the old and construction of the new viaducts was rented locally.

The rebuilding of the Marshall St. Viaduct was done by contract by the Wisconsin Bridge & Iron Co., of Milwaukee. The S. M. Siesel Co., also of Milwaukee, built the James River Bridge under a contract. An article on construction features of this project will appear in a subsequent issue.

Direction

John J. Wicker, Jr., is president of the Richmond Bridge Corp. Allen J. Saville, Inc., and Lee, Smith & Van Dervoort, Inc., both of Richmond, were engineers, with A. C. Janni of New York as consulting engineer in charge of design. R. S. Hummel, vice-president of Allen J. Saville, Inc., was in direct charge of all field activities.

Motor Truck-Trailer Trains for Roadless Country

Tests by British engineers in African colonies and in the interior of Australia indicate commercial possibilities of truck trains in developing frontier territory

TRANSPORTATION as a vital means of opening up the still large isolated areas of the world has apparently found a powerful aid in the truck and trailer train and the diesel engine. Working tests conducted with a pioneer train in the Gold Coast of Africa and later with an improved train in Australia have given such favorable results that both of the test trains have been bought by the governments of the countries in which the tests were made, two have been ordered by the Russian government and another by the Crown Agents for the Colonies for Tanganyika Territory, Africa. In the Gold Coast tests the train traveled 8,000 miles in actual commercial service. The Australian tests covered 9,937 miles, also in actual commercial service, and have recently been reported in detail by the Overseas Mechanical Transport Directing Committee sponsored by the British Secretary of State for Dominion Affairs and the Colonies, which has furnished this journal with the accompanying map and views of the experimental train.

FIG. 1—ROUTES TRAVELED by truck-trailer train in 29-week test of possibilities and cost of commercial haulage in the interior of Australia.

The Australian test train shown by Fig. 2 consisted of an eight-wheel truck designed to carry 3 tons and two eight-wheel trailers each of a capacity of 6 tons. Actually 4 tons could be carried on the truck and 8 tons on each of the trailers. The truck had a 6-cylinder 130-b.hp. diesel engine with drive to all eight wheels; the first and fourth pair of wheels were steered. Both truck and trailers were mounted on bogies; all wheels of the truck and diagonally opposite wheels of the trailers were air-braked. The tires were 10-50-20 in., inflated to 38 lb.

The train made in England was landed in Adelaide, and after a demonstration over 550 miles in South Australia it was driven to Alice Springs in the Northern Territory. From there it made journeys to Birdum, the terminus of the North Australia Railway running south from Darwin, to Anthony Lagoon, to Borroloola and other places in the Northern Territory (Fig. 1). The test was conducted under commercial running conditions, ordinary commercial freight being sought and paid for. The vast majority of the 9,937 miles traversed, as can be seen from Fig. 3, could only be called earth roads by courtesy. These bush tracks

FIG. 2—TRUCK-TRAILER TRAIN loaded with 3,000 gal. of gasoline at Birdum for delivery beyond railhead into the interior of north Australia.

FIG. 3—CHARACTER OF ROADS traveled by truck-trailer train in Australian tests, shown crossing Leila Creek between Borroloola and Anthony Lagoon.

were seldom either graded or drained and usually consisted only of two ruts made by previous vehicles. As the gage of these ruts did not fit that of the unit, their presence only made the task of the latter more difficult. The surfaces varied from deep sand and plains covered with loose stone, to heavy sandy creek crossings, black soil, and deep mud after rains, and the temperature was at times tropical. During the whole time, despite the severity of the test, there were only two mechanical breakdowns, both occurring to standard parts and neither of serious importance.

The fuel consumption averaged 3.15 miles per gallon of diesel oil, and the speed 12.87 miles per hour over the entire distance covered by the tests. These figures were regarded as most satisfactory considering the 81,933 ton-miles involved and the cross-country conditions of operation. It was found possible to cover distances up to 170 miles in a day at an average speed of 17.45 miles per hour when lightly loaded on return journeys. On some of such journeys the fuel consumption averaged 4.5 miles per gallon.

The cost per net ton-mile at which the train worked during the 29 weeks' tests was 3.70d. It is important to note that this is an actual working figure and not an estimated one. Depreciation is based upon a life of 100,000 miles, and interest is calculated at 4 per cent; both of these are conservative figures. While on all outward journeys the unit was loaded to its normal capacity of 15 tons and sometimes carried up to 20 tons, little return freight could be obtained, with the result that the average load was only 8.72 tons. This naturally reacted on the cost per ton-mile, which would have been considerably lower with better average loading. Another factor that increased the cost per ton-mile was the large amount of time that had to be spent on-loading and off-loading due to the lack of facilities and appliances. The proportion of working time spent in loading, off-loading and waiting for spare parts amounted to as much as 30 per cent of the total period occupied by the tests.

It is urged by the report that the tests be continued, and for this purpose a train of 30-tons load capacity has been designed.

Control-Survey Costs Lowered by C. & G. S. Engineer Parties

REDUCED COSTS of geodetic control surveys have been reported by the U. S. Coast and Geodetic Survey for its 1934 operations. During that and the previous year a greatly expanded survey program was carried on as relief work, using funds provided by the emergency relief administration and it was possible to make definite headway toward complete coverage of the country with closely spaced control-survey lines. The results of this work were particularly valuable as a foundation for the surveys and maps required for large-scale planning and resource study.

Three factors mainly were responsible for the lowering of costs: continuity of operation, character of personnel, and competition between the field parties.

The relief-survey program was carried on without seasonal interruption, the parties working in northern sections of the country during the summer and in southern sections during the winter. In earlier years the survey appropriations were too small for continuous operation throughout the year, and efficiency was lost through repeated reorganization.

During normal years there was a considerable turnover in personnel, and many of the field employees were unskilled laborers who could hardly take more than a nominal personal interest in the work. Under the relief program, however, large numbers of professional engineers made application for work in any capacity available, and in consequence two-thirds of the field force was made up of engineers, even in positions such as building signals or driving trucks. The keen and intelligent interest taken by these men in the work as a whole and the effort they made to promote the success of the work contributed to its increased efficiency.

Finally, a spirit of friendly competition developed between field parties working in the same general neighborhood. Many parties turned in unusual records of work, evidently the result of efforts to outdo competing parties. The competitive effort developed particularly during 1934, and brought the unit cost well below the 1933 figure, although the number of engineers employed was practically the same for the two years.

Self-Liquidating Plan for Oregon's Coast Highway Bridges

By Conde B. McCullough
Bridge Engineer, Oregon State Highway Dept., Salem, Oregon

DURING the spring of 1934, the Oregon state highway commission entered into contract with the PWA for a loan and grant of $5,602,000 with which to construct the five remaining major bridges on its Coast Highway. The loan contract in its final form is the result of negotiations extending back over a period of several months, and provides for a federal grant of approximately 30 per cent of the cost of the project and a loan covering the balance. The loan is at 4 per cent with an amortization period of 28 years and is payable both as to principal and interest from revenues derived from the imposition of tolls over these bridges.

Prior to the state's application, a rather extensive system of traffic surveys throughout this region had been made by the U. S. Bureau of Public Roads. These surveys were made in 1929 and 1930. Based on these studies and augmented by data as to ferry traffic in 1932 and 1933, the traffic flow and traffic density diagrams of Figs. 1 and 2 were developed.

The five bridges, now actively under construction, are as follows:

Yaquina Bay Bridge—Three steel arch spans flanked on either side by reinforced-concrete arch and deck girder construction. The channel span is 600 ft., and the flanking spans 350 ft.

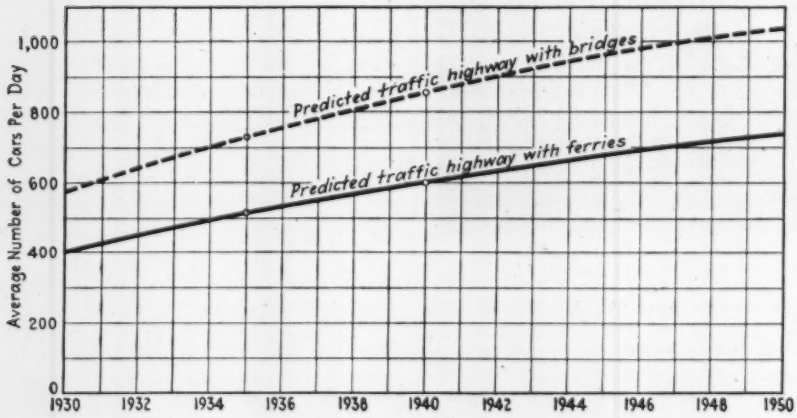
Alsea Bay Bridge—Three concrete arches of bowstring type flanked on either side by three 150-ft. deck arch spans and by a reinforced-concrete viaduct. The central bowstring span is 200 ft., and the flanking spans are 143 ft.

Siuslaw River Bridge—A 140-ft. bascule span flanked on either side by reinforced-concrete bowstring arches and concrete viaduct.

Umpqua River Bridge—A swing span of 430 ft., flanked on either side by bowstring concrete arches of 154-ft. span and long concrete viaducts.

Coos Bay Bridge—A steel cantilever having an over-all length of 1,708 ft. flanked on either side by long concrete arch and viaduct approaches.

FIG. 1—PREDICTED AVERAGE DAILY VOLUME of traffic over five Coast Highway bridges in Oregon.



FINANCIAL SET-UP FOR OREGON COAST HIGHWAY BRIDGES

Year	Gross Receipts	Disbursements: March 1, Principal Payment	Disbursements: Interest 4%	Disbursements: Operation, Insurance and Incidentals	Disbursements: Maintenance	Accumulated Reserve
1936	$337,899	$ None	$160,000	$55,000	$10,000	$112,899
1937	350,035	100,000*	160,000	55,000	10,000	137,934
1938	361,532	100,000	156,000	55,000	10,000	178,466
1939	373,030	105,000	152,000	55,000	10,000	229,496
1940	383,889	105,000	147,800	55,000	15,000	290,585
1941	394,109	110,000	143,600	55,000	15,000	361,094
1942	404,329	110,000	139,200	55,000	15,000	446,223
1943	413,271	115,000	134,800	55,000	15,000	539,694
1944	422,853	115,000	130,200	55,000	15 000	647,347
1945	431,795	120,000	125,600	55,000	20,000	758,542
1946	439,460	125,000	120,800	55,000	20,000	877,202
1947	447,764	130,000	115,800	55,000	20,000	1,004,166
1948	455,429	135,000	110,600	55,000	20,000	1,138,995
1949	462,455	140,000	105,200	55,000	20,000	1,281,250
1950	468,842	145,000	99,600	55,000	20,000	1,430,492
1951	474,591	150,000	93,800	55,000	20,000	1,586,283
1952	479,701	155,000	87,800	55,000	20,000	1,748,184
1953	484,173	160,000	81,600	55,000	20,000	1,915,757
1954	488,644	165,000	75 200	55,000	20,000	2,089,201
1955	492 476	170,000	68,600	55,000	20,000	2,268,077
1956	496,309	175,000	61,800	55,000	20,000	2,452,586
1957	499,502	180,000	54,800	55,000	20,000	2,642,288
1958	502,696	185,000	47,600	55,000	20,000	2,837,384
1959	505,890	190,000	40,200	55,000	20,000	3,038,074
1960	508,445	195,000	32,600	55,000	20,000	3,243,919
1961	511,000	200,000	24,800	55,000	20,000	3,455,119
1962	512,916	205,000	16,800	55,000	20,000	3,671,235
1963	514,833	215,000	8,600	55,000	20,000	3,887,468
	$12,617,868	$4,000,000	$2,695,400	$1,540,000	$495,000	

* The contract provides for the first principal payment March 1, 1938. It is therefore considered as coming out of 1937 revenues.

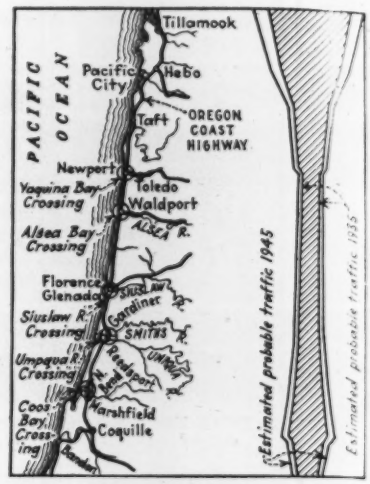


FIG. 2—TRAFFIC FLOW for Oregon's Coast Highway with five new toll bridges located as shown.

The lower curve of Fig. 1 passes through a traffic density of 510 cars per day on the 1935 vertical, which is the figure obtained by scaling the average traffic ordinate in Fig. 2 throughout the zone embracing the five bridge structures. This figure is considerably less than the average prediction for 1935 for the entire highway (824 cars per day). The reason for this discrepancy lies in the fact that this last figure is the average for all traffic stations on the highway, which truly reflect through traffic conditions, whereas the lower curve of Fig. 1 is based upon the marked constriction of traffic flow throughout the zone embracing the ferries. This lower traffic curve may therefore be said to reflect those conditions which would obtain with the present ferry facilities, whereas the upper curve of Fig. 1, being plotted through a traffic density corresponding to 88 per cent of the densities indicated in the bureau's studies, is representative of the minimum traffic flow that may normally be expected when the present ferry facilities are replaced with bridge structures.

The accompanying table indicates estimated gross receipts from bridge tolls, based upon the lower traffic curve of Fig. 1 in comparison with the disbursements necessary for principal payments.

interest, operation, insurance, incidentals and maintenance in accordance with the requirements of the government's loan contract.

The toll rates that have been adopted by the state highway commission and that were used in the above calculations are as follows:

Class of Vehicle	*Toll Charges Per Bridge*
Automobiles, including driver	$0.20
Additional passengers in automobiles	0.05
Trucks under 3 tons	0.60
Trucks, 3 tons and over	0.90
Buses, including driver	0.90
Passengers in buses (per passenger)	0.05

The federal grant is computed on the basis of 30 per cent of the cost of labor, plus materials, and it may be that the total amount of the loan will slightly exceed the $4,000,000 figure used in the table. It will be observed, however, that even with the most conservative traffic estimate, the gross receipts will be sufficient to operate and maintain the bridge structures, to meet all interest and principal payments as they become due, and in addition, to accumulate a reserve of approximately $1,000,000 in a twelve-year period of operation.

These calculations are based upon an ultra-conservative estimate of traffic flow, so that it is quite probable that the revenues given in the table will be materially exceeded, thus permitting a marked reduction in tolls or the accumulation of a sufficient reserve to permit the bridges to be made free in a much shorter period than the amortization time stipulated in the loan contract.

After the Code, What?

Leaders in the construction industry and in related industries give their views as to the possible effect of voiding the construction code and as to means for attaining some of the objectives of the code

THE CODE of the construction industry, along with all other codes written under the National Industrial Recovery Act, was voided by the U. S. Supreme Court's decision in the case of the Schechter Poultry Corp. *vs.* the United States, handed down on May 27, as noted briefly in our news pages last week. The basic code for the construction industry has been in effect since March 2, 1934, and chapters affecting many of the major branches have been in effect for a like or lesser period. Other chapters were still in the NRA mill when the Supreme Court's decision was rendered.

Under the construction code, limitations on wages and hours of employment have been in effect and the prices of materials and equipment have been stabilized by codes in effect in other industries. Limitations upon bidding and other competitive practices also have been in effect, nominally at least, in many branches of the construction industry. Code and sub-code authorities have been set up, bid depositories established, and a few area agreements as to wages and hours reached. Now these all are made null and void.

Decision raises new problems

What will be the effect of this abrupt change on the industry? Can any of the good features of the code provisions be preserved? If so, by or through what agency? Can some form of voluntary agreement be made effective?

In considering the possible effect of code abandonment upon construction costs and prices, it is to be remembered that just at present much construction is on government work or on work financed by the government.

As a practical step in maintaining the larger objectives of NRA, the President has proposed legislation that would require all contractors and subcontractors supplying goods and services to the federal government to maintain substantially the same requirements on hours and wages as provided in the codes by which they were governed. To what extent this requirement will be effective remains to be seen as government purchases account for probably not more than 1 per cent of industrial production. The same requirement will apply to PWA loan-and-grant projects but, in general, the PWA scales are higher than were code wages and the work week is shorter.

Code Authority marking time

Pending clarification of the new situation created by the Supreme Court decision, the Construction Code Authority has suspended active operations while leaders in the industry are seeking to determine how best to salvage the gains in integration and regulation that were realized from the code. Collection of assessments and attempts at enforcement have, of course, been discontinued.

The NRA has issued no instructions to code authorities as to their further operations except that they should proceed with the advice of legal counsel. The Construction Code Authority and many of the divisional code authorities are incorporated, and hence have a corporate entity to dissolve regardless of the suspension of their code administrative activities. Several of the divisional code authorities have issued instructions to local administrative committees and agencies to suspend activities, dismiss complaints, close bid depositories and incur no further expense, but they urge that administrative committees hold themselves intact until further plans for industry integration are developed.

The Contractors' Divisional Code Authority likewise is marking time. All applications for registration of construction work and all registration fees have been impounded since 2 p.m. Monday, May 27, when the reading of the court decision was concluded. Further action will be discussed at a meeting on June 6. There is involved not merely the central office of the code authority but 49 local agencies distributed all over the country. No decision has been reached as to whether these offices will continue to function in an effort to continue coordination of the various branches of the industry.

Opinions on code abandonment

Questions such as those outlined in the opening paragraphs have been addressed by this journal to leaders in the industry and in code administration, and to men in important positions in the related materials and equipment fields. Their replies are given below. For obvious reasons none of those who have replied have attempted to cover all the questions that arise. Too little time has elapsed since the decision was handed down for anyone to give careful study to all matters bearing on the changed conditions. Nevertheless, the opinions that are given will be found helpful in planning the future program for the construction industry.

Integration should be maintained

It is too early to predict the effect on the construction industry of termination of its codes. The gains in integration of the industry resulting from the codification effort can be conserved in the Construction League of the United States.

The following resolution was adopted this morning (May 31) by the 67th convention of the American Institute of Architects in session at Milwaukee: "Resolved, That the American Institute of Architects in its 67th convention assembled instruct delegates to the Construction League to cooperate in every practical way with the delegates representing the American Society of Civil Engineers, the Associated General Contractors of America, the Producers Council, and the other national organizations associated in the Construction League in order that through the leadership of the Construction League there may be preserved to the construction industry those valuable elements and results of the coordination of interdependent functional groups in the industry that it was the purpose of the code to advance: Be it further resolved, that the Institute hereby pledges its aid toward the extension through the League

of such agencies as the League may now have or may set up to forward these ends."

A similar resolution was adopted on Thursday by the Producers Council at its 12th annual meeting at Milwaukee.

STEPHEN F. VOORHEES,
Chairman, Construction Code Authority.

Builders' code not approved

Chapter II-A, building contractors' division, of the construction code has been in the hands of the NRA officials since Oct. 8, 1934. Some minor revisions were made on May 2, 1935, and this ninth edition was finally forwarded to the Administrator, W. A. Harriman, two weeks ago for approval, but has not been signed. Technically, therefore, the builders have no code.

I question the possibility of getting the general building contractors to agree to voluntary acquiescence with the provisions of Chapter I and Chapter II after the unsatisfactory experience they have had during the past year, although there are several fundamental features that should be preserved for the betterment of the building industry.

DANIEL T. WEBSTER,
Chairman, Executive Committee,
Building Codes Committee.

No real test of highway code

Experience during the period in which Chapter II-C of the construction code has been effective does not warrant elimination of any particular element from it because there has been no real test of its value as a whole in governing the industry, since it lacks the backing of positive enforcement and since there has been no opportunity to function with this chapter under a complete code structure. Therefore, I do not favor hastily casting aside that which has been developed unless we are certain of the course upon which we must travel. Until this is determined, there is no basis upon which to qualify any such elimination. Any attempt to make code provisions effective by voluntary agreement will be a useless effort unless compliance can be forced on the few. No results can be had through consent of the many. We cannot alter our viewpoint and will therefore take no part in such a movement.

ROBERT E. O'CONNOR,
Highway Contractors Code Division.

Strengthen the Construction League

The summary termination of the construction code is extremely unfortunate. Like every new piece of legislation, the National Industrial Recovery Act had many defects which could have been corrected by proper amendments. Nevertheless, it did have the effect of integrating the industry and making it more industry-conscious.

One of the main things which will be missed with the disappearance of the code is the beginning made by the code authority in collecting and collating statistics in regard to the industry. This was a work that should have been done long ago, and unfortunately it will not now be possible to continue it effectively.

One of the principal benefits of the code was the stabilization of hours and wages. There is some danger that price cutting based on lower wage standards may follow the disappearance of the code. This can best be combated by organized efforts of the trade associations comprising the Construction League and other trade associations not now in the League who were sponsors for codes. The Producers Council and other associations representing manufacturers of engineering products have their own codes, and I cannot pretend to speak for them at this time.

It is too soon to talk about any reorganization, or to attempt to effect any association for voluntary codes. We shall have to wait until a program has been determined. Personally, I feel that the summary abolition of codes puts the issue squarely up to trade associations of the Construction League, to strengthen that organization in such a way that it may continue to exert a beneficial influence on the industry and retain for the industry the great gains in integration, policies and business ethics effected under the code.

JOHN P. HOGAN,
General Chairman, Construction League
of the United States.

Too much attempted

It is my firm opinion and always has been that the codes as promulgated covered entirely too much ground and attempted to accomplish the impossible.

If reasonable minimum wage rates and fair and equitable maximum hours of work can be preserved, I would say we had accomplished a whole lot. Such restrictions on watchmen, clerks, cooks, etc., as prescribed under Article 3, section 1, paragraphs a and b, should, however, be eliminated. They are unjust, unworkable, and would have been ignored by most of the members of the industry.

To make any voluntary agreement effective to me seems impossible. The Associated General Contractors of America have an excellent opportunity to preach the foregoing to all contractors of record, and should put on a campaign at once to try to preserve the minimum wage and maximum hour provisions of the code.

C. C. BURGHART,
Secretary, Heavy Construction
and Railroad Contractors,
of the General Contractors Division

Continue wage and hour provisions

It is my opinion that the abandonment of codes will be detrimental to the construction industry in that the wage provisions and the provisions for fair trade practices have been an effective deterrent to destructive price cutting and chiseling. The Construction Code Authority has recommended to the various divisions of the construction industry that they continue the wage and hour provisions of the code.

The discontinuance of the statistical program organized under the construction code, and well under way, is to be deplored. Such a program has been long needed.

The integration of the construction industry, well advanced through its codes, and many of the other gains made under the codes, can be best maintained by strengthening the Construction League and its various member associations.

B. R. VALUE,
Executive Director, Construction Code Authority.

Premiums, not prohibitions

It seems too early to predict what effect, if any, abrogation of the present codes by the Supreme Court decision will have on the construction industry, nationally or locally. It will be necessary to determine if construction projects, other than those along state boundaries, are purely intrastate operations or to what extent interstate transactions affect their industrial policies before deciding whether government regulation is industrially wise, timely or necessary in the public interest.

Continuous industrial progress is vital, and if fair competition in industry is to succeed, it seems fundamental that it be based on premiums for conformance rather than penalties for non-compliance. Through some system of industrial discount transmitted from the raw-material producers clear through the industry to the ultimate owners of completed construction projects, a sound inducive program of industrial self-regulation can be formulated with sufficient reward incentive to warrant its universal support and to insure its nation-wide success. This is not merely high-sounding wishful thinking or cheerful optimism, but is based on practical factual precedents. Just as honesty over a period of years has proven itself to be the best industrial policy and the foundation of our credit system, so industrial cooperation will more and more rapidly demonstrate itself necessary through service justification to insure individual commercial self-preservation. It is the only possible bulwark against socialism, communism, unwarranted intrusion of government and disruptive competition of other industries.

Construction is a far-flung giant industry, and like all gigantic movements it is moving slowly but irresistibly forward. Under the leadership of the Construction League of the United States and its constituent organizations, working in unison, the industry can and will continue to stride onward. It must assume its proper place commensurate with its importance in the progressive industrial movement in America to provide ever-better standards of living, working and recreation for all the people, which is the nation's worthy goal.

A. P. GREENSFELDER,
Second Vice-President,
Construction League of the United States.

Save area agreements

All provisions of area agreements pending before the NRA, approximately 25 in number, should be saved as well as the labor and trade-practice provisions of our chapter of the construction code. I doubt very much if it is possible to make these area agreements reasonably effective by voluntary agreement.

HOMER T. BOOTH,
Mason Contractors Association.

Coordinated effort needed

Without coordinated effort on the part of industry I believe that abolition of the codes will create chaotic conditions both as to the effect on wages and hours and on price structures. Unjustifiable price reduction will not stimulate an appreciable increase in volume, and uncertain market conditions will naturally deter buying.

O. W. RENKERT,
Metropolitan Paving Brick Co.

Confusion only temporary

A prominent manufacturer of construction equipment who asked that his name be withheld states:

"I believe that code abolition will cause a short temporary confusion but the vol-

ume of business will continue to increase due to natural causes. Believe the present labor rates will be generally maintained, which naturally will eliminate any possibility of lower prices."

Equipment distributors disturbed

Code abolition placed equipment distributor in a state of fear as to the possibility of making sufficient profit to carry on. Price chiseling started early in May and will undoubtedly increase by midsummer. Ridiculous trade-ins will be involved in many sales without codes. Can see profitless prosperity era during spending the four-billion fund.

A. C. BLAISDELL,
Associated Equipment Distributors.

Cement prices unaffected

The cement industry as a whole is maintaining code wages and hours and consequently code abolition will have little if any effect on cement prices, especially since present prices are unprofitable to manufacturers. Volume will not be affected to any appreciable degree.

GEORGE F. COFFIN,
President, Cement Institute.

A new cycle beginning

The death of NRA should be the birth of a true industrial democracy for construction—the beginning of the next cycle in the development of self-government by the industry. If the construction industry is to go forward, there is no alternative to taking the next step voluntarily and on its own motion. The Supreme Court not only swept away the code; it also removed the sanction of federal law for the industry's continued integrated existence. The court's decision is a challenge to the pioneering spirit which, down through the centuries, has characterized builders and their industry and left a record of ingenuity, courage and leadership.

A convention should be called by the Construction League of the United States. It should be called at once, before disintegration has blotted out the memory of those high hopes which after months of heartbreaking effort found expression in the code structure. It should be a convention of representatives of all associations whose members are engaged in the construction industry; representatives of associations of producers whose products are consumed in construction, and representatives of employees.

This convention should decide whether the integration of the industry, accomplished under the code, is to be continued and given a new organic form and function.

The convention should adopt a statement of broad principle and purpose; establish a procedure for the election of representatives vested with authority to prescribe rules and regulations, consistent with the principles and purposes adopted, for the conduct of the industry; provide for a system of local courts of arbitration and appellate regional and national courts; and fix a system of taxation for producing the necessary operating revenue.

The organization here envisaged should have local roots through which the national agency shall draw its authority to coordinate local activities, and to establish local organizations where none exists. Primarily, it should be a cooperative organization, but prepared always to take the offensive against practices that are subversive of public interest. It should not start with a lot of restrictions and prohibitions. These may be adopted as the organization grows and spreads, and as experience shows them to be practicable and in the best interest of the industry and those the industry serves.

Agreement should be the central idea, the mainspring of the whole movement—agreement to promote the purpose and principles agreed to; agreement to eradicate the chiseler by out-chiseling him; agreement to maintain agreed minimum wages and maximum hours of work to secure bidding parity; agreement to arbitrate disagreements. The character of this organization should be on agreement among its members to be governed by consent.

If we have the determination and a little patience, the industry can do for itself, with infinitely greater satisfaction and permanence, what the Supreme Court has said the government cannot do for it.

SULLIVAN W. JONES,
Chairman, National Construction Planning and Adjustment Board.

Letters to the Editor

Misplaced—One River

TO THE LIST of unpardonable errors in publishing, on which the misspelling of an individual's name leads all others, there must now be added the misapplication of the name of a river. Recently we labeled the Missouri River at Omaha the Mississippi, in spite of the fact that we had just come from there. The attention-calling has been voluminous. We can do no more than abjectly acknowledge the error as penitently as possible and publish some of our recent mail, which indicates real and proper concern for accurate geography. —EDITOR.

Sir—I find on p. 728 of your highly esteemed publication (May 23 issue) that the Mississippi River has been moved over to the west far enough so that it now flows between Omaha and Council Bluffs. We people living along the Old River are somewhat jealous of our inland waterway, and don't like having it stolen away from us in this manner. We would like to know whether it was the PWA, CCC, NRA, AAA, HOLC or ENR that stole it. We want to bring legal proceedings against the guilty party. You are not asked to incriminate yourself, of course, but we do hope that you will tell the truth, the whole truth, so help you Abe Lincoln.

Quincy, Ill., May 27, 1935. W. R. GELSTON, Supt. Waterworks.

Sir—I have heard many tall stories of the gymnastic feats of the Missouri and Mississippi Rivers, but the Paul Bunyan-like leap of the Mississippi 300 miles west to Omaha, shown in Fig. 2, p. 728 of your May 23 issue, has them all beat. What became of the Missouri?

Clinton, Iowa, May 28, 1935. CHAS. CHASE, Consulting Engineer.

Sir—I have always had the highest admiration for the ability and foresight of *Engineering News-Record* and am glad to say that my faith has been justified in the issue of May 23, where on p. 728 you indicate that not only is Omaha building a bridge over dry land to span a river into the future but the map shows that the river itself is to be shifted 300 miles out of its course. In other words, that the Mississippi, in place of running down past Davenport and Burlington, is to go between Council Bluffs and Omaha. I would like to inquire what has become of the good old Missouri River according to your map?

New York, N. Y., May 24, 1935. J. P. H. PERRY.

Solving Rigid Frames

Sir—We found the comments of Commander Moreell and Dean Turneaure, in their letters (*ENR*, Feb. 21, 1935, p. 295) very interesting, as the systems developed and explained by these writers have something in common with our method of direct distribution (*ENR*, Dec. 20, 1934, p. 782).

The writers were familiar with the work of Mr. Epstein, as developed and edited by Commander Moreell, and published by the Navy Department in their "Standards of Design for Concrete," although the conception of our method antedates this publication. We were not previously aware of the excellent changes which Dean Turneaure and his co-author had made in their "Principles of Reinforced Concrete Construction," but since his proposed method for the solution of continuous beams and frames is identical with that of Mr. Epstein, the following comment will apply with equal force to either method.

The only real point of similarity in the above methods and our method, either in conception or development, lies in the use of the carry-over factor, used in our method secondarily and in the other two methods primarily. This factor has been employed either explicitly or implicitly by Fidler, Ostenfeld, Richart, Nishkian and Steinman, Wilson, and several others. No claim was made by us for originality in this respect. Our original concept was the unique definition of end restraint p in terms of which both the carry-over factor f and the reduced moment coefficient m may be expressed. We feel that this is a distinct advantage in that it leads to a sequence of operations that gives a clear mental picture of the action of moment distribution.

JOHN C. SCHULZE and WILLIAM A. ROSE.

New York, N. Y., May 7, 1935.

(EDITOR'S NOTE—Mr. Epstein states that, "In my method there is no conception at all of carry-over factor, though the values of α and β in the end figure appear to be so. The values of α and β are physical constants of the system, independent of the nature of loading." To the general reader, the point at issue will be minor compared to the fact that two significant methods of rigid-frame analysis are available to challenge his attention and study.)

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June 6, 1935

Danger Threatens

LATEST REPORTS from Washington indicate that the $4,000,000,000 relief-works program continues to stagnate and is in danger of being wrecked. None of the money has yet been put to work, though it is two months since the act was passed and six months since it was formulated. Nor have the policies that must govern the selection of projects been laid down as yet. For weeks and months, plans for regimented charity of CWA and CCC type have been in conflict with plans for constructive work carried out by sound procedure, and according to close observers the clash continues, with Administrators Hopkins and Ickes the chief figures in the two camps. There is now a threat that even the highway part of the program may become a source of dispute. The administration appears to stand aloof while the wrangling goes on and while the best part of the season is wasted. Though the task of organizing the program is difficult, this does not account for the amazing delays. If the delays are intentional, Congress should take responsibility for insisting on early action.

Private Construction Gaining

CONSTRUCTION VOLUME FIGURES for the first five months of the year clearly reveal the effects of the delay in the relief-works program. Engineering construction activity as a whole is 9 per cent behind that of last year, while public works show a loss of 18 per cent. This loss is due largely to decrease in federal government construction, which stands at only 58 per cent of its 1934 value. Highway construction, awaiting the start of the $800,000,000 program, has slumped to 70 per cent of last year's volume at this date. The bright spot in current construction figures is the resumption of private engineering construction, which shows a gain of 38 per cent over 1934 and has reached the highest five-months volume in four years. Much of this gain has come in industrial building, now 71 per cent ahead of last year and at the highest point since 1930. Residential building, with a gain of 80 per cent over last year, is forging ahead similarly. These gains in private construction are tangible evidence of returning business courage, faith and activity. But, heartening as they are, they are overshadowed by procrastination in pushing public works, so greatly needed at the moment to lighten the relief load.

New Motor Truck Fields

AMERICAN THINKING in developing truck-trailer train transportation has been in general based on the presumption that good roads are provided. A considerable group has in fact taken the stand that special truck roads separate from general traffic routes and of sturdier construction are necessary to bring this kind of vehicle-train haulage to full maturity. On the other hand, Europe, and particularly Great Britain, has developed a radically different view, namely, that the power truck-trailer train is a transportation device of special value for roadless country in process of colonization and commercial development. Both in the British African colonies and in Australia, as told in this issue, experimental runs of truck-trailer trains in roadless country have been so successful that the several units have been quickly taken over by the government departments and are being operated in commercial service. The United States offers no such broad fields for roadless transportation development, but opportunities are not entirely lacking, and in the Americas as a whole there are large territories that have the same hinterland conditions as Australia and the African Gold Coast colonies. It is possible that American motor-truck manufacturers might profitably look for a market in these new fields.

Planned and Managed Action

THE INEFFECTIVENESS of separate, uncoordinated action to create employment and build business recovery has been demonstrated time and again during the past five years of depression experience. It was revealed as early as the opening months of 1930, again in the following three years, and under the present administration in the disappointing results of failure to coordinate the construction activities of PWA, the work-relief operations of CWA and the charity work of the FERA. Throughout, attempts to fight the depression have been characterized by absence of purposeful and planned central management. It is this fact that gives major importance to the Wisconsin Plan outlined by Governor La Follette in a special interview in last week's issue. Any undertaking of such huge dimensions as the recovery work of a state or of a metropolis has to face formidable difficulties, as was clearly brought out by the account of the works division operations in New York City, also published in last week's issue. The experiences of that enterprise illustrate the nature of the problem involved and lay stress on the necessity of central planning and financial control with decentralized management of execution. The two new agencies that are to be set up in Wisconsin, a corporation to control finance and another one to deal with the directive planning, are well adapted to meet this requirement. If they get into action soon, we will have a valuable working demonstration of one of the best forms of relief-recovery effort yet devised.

Proper Answer

REPORTS OF THE AUDIT of TVA operations that were presented before the Military Affairs Committee of the House last week by Comptroller-General McCarl gave an unbelievable and, as the sequel proved, a scandalously misleading impression that the TVA's operations lack integrity and efficiency. It is therefore gratifying to learn that Arthur E. Morgan, chairman of the Authority, answered the Comptroller-General's charges point by point and thoroughly. One of the basic charges was that the war-time riot of expenditure for Wilson Dam, the Muscle Shoals nitrate plants and associated properties was falsely written down on the TVA's books. This is an old canard. It would have been easy for the Comptroller-General to verify the fact that the book value represents sober, present-day, usable value, computed from the recorded construction quantities and actual present-day unit costs; yet, forgetting the responsible character of his office, he put forward figures implying that the TVA had juggled its books to change an investment of more than $130,000,000 to less than

half that value. Engineers are interested also in the "exceptions" taken by the audit to purchases of construction equipment, where in many instances a bid other than the low bid was found best—quite within the law and within good engineering practice, but apparently not to the Comptroller-General's taste. If governmental accounting rules stand in the way of considering quality of product and range of performance in comparing bids, then it is time that the rules were modernized.

A Historic Chapter Ends

AMID the sweeping destruction of the NRA code system wrought by the decision of the U. S. Supreme Court, construction stands in a unique position. In respect to immediate effects it is far less concerned than the manufacturing and trading industries, for its code had not had time to change accustomed practices greatly. In the longer outlook, however, it is much more deeply affected, for the ultimate results of code operation promised to modernize its structure and bring large progress in its business and human relations. In this situation everyone engaged in construction cannot fail to give thought to the future course and to the possibilities of salvaging the best of what has been lost with the passing of the code.

It is well to keep in mind clearly the meaning of the Supreme Court's findings. The Court decided three major points: (1) That far-reaching delegation of legislative power is unlawful, (2) that local activities are not a part of interstate commerce, and (3) that building is a local activity. Building, of course, includes every variety of construction. It follows that federal compulsory regulation may not be applied to construction, except by contract.

The immediate effects of the decision on construction will probably be minor. Except for federal contracts and federally financed work (if a suggested new law is enacted), the sway of the construction code is of course over—though voluntary observance is within anyone's rights. So also the code authorities and boards are deprived of their status. These are the outstanding changes.

Construction costs should be little affected, since important changes in price of materials and equipment are improbable, and labor rates are equally likely to hold their level. The activities of engineers and architects will be unchanged, while contractors and subcontractors will be only slightly affected aside from being relieved of the payment of registration fees. Any incidental adjustments that may prove necessary should be accomplished quickly and without trouble.

Moreover, abolition of the code is less momentous now than it would have been a year ago. Recovery has advanced, and a strong and healthy breeze is enlivening business. There is apparent a rebirth of enterprise that presages a steady rise in production and employment. All the conditions thus suggest that construction has no serious reason for immediate concern over the ending of its code.

But in the longer view, as we have said, the effect of the change upon construction is profound. Let us consider what construction expected from its code, what gains were realized, and whether these must now be given up.

Composed of many different kinds of working units functioning without cooperation, scattered afar and shifting in location, construction has ever been an aggregation of industrial units rather than an industry. Its members did not realize that they had common problems. Its labor relations were bad, as intermittent employment gave the workers small annual earnings despite high wage rates, and its relations to finance, purchase and sale were almost equally unsatisfactory. Such conditions bred inefficiency, high costs, uncertain quality, and instability of the industry.

It was these characteristics that it was hoped to correct by placing construction under a code. Major gains expected were a unification of the industry so that joint problems would be jointly discussed and carried to settlement, the elimination of waste inseparable from uncoordinated control, assurance of higher quality of product, increased income for the worker, decreased construction costs. Finally it was hoped that stabilization would be promoted by guiding the operations of construction through statistical analysis, study of works programs and budgets.

The code set up for the purpose was exceptionally free from selfish purposes. Aside from fixing minimum wages and maximum hours it established fair bidding practices while avoiding the questionable expedients of price control and control of expansion. In addition, it set up a remarkable arbitration tribunal for the improvement of labor relations, the Construction Planning and Adjustment Board. Thus it was a document of progressive and constructive kind. That it did not gain universal support is chargeable to the magnitude of the task.

What has the code accomplished? It led to a clearer recognition of the singleness of interest of all parties to construction and developed a habit of looking at the questions of any group from an industry-wide viewpoint. It improved labor relations, and made a start on further betterment. The plane of bidding ethics was markedly raised. A study of the industry's operations as a whole was begun, as a first step toward measures that in time might bring useful stabilization.

Looking at these results and their bearing on the future, it is plain that most of them ought to be preserved, and that some at least are attainable by voluntary association. To develop methods of practical cooperation within the law to the same or better effect as that achieved under the code is now the industry's problem.

Until the government has clarified its intentions, little progress can be made toward its solution. But in the meantime it is certain that some of the tasks relinquished by the code authorities must return to the hands of voluntary industry associations, and that upon these—which in last analysis means upon the leaders of construction groups themselves—falls a major responsibility. The Construction League, sole central forum of construction interests, stands in a peculiarly important position to this task. Purposeful reorganization of its machinery to carry out these tasks can accomplish results of great present value.

The Supreme Court's decision ended a chapter in the nation's industrial history, a chapter of special significance to construction. The attempt to bring about mandatory self-regulation to replace the waste of competitive warfare by wisely controlled rivalry, with a view to the general welfare, has failed. But just as surely as this chapter has ended, a new one is beginning. The men of the industry have the opportunity of deciding whether it is to become a mere reversion to the practices existing prior to 1933, or whether the gains hoped for and in small part realized are to be retained.

CURRENT NEWS

Disagreement Over Types of Projects Delays Relief Works Program

(Washington Correspondence)

THE RELIEF WORKS PROGRAM is at a standstill because of the split between Administrators Hopkins and Ickes on the policy by which to govern selection of projects. Hopkins is enforcing his preference for low-cost projects by holding up in the Works Progress Administration many applications filed by PWA for non-federal projects and also by federal agencies for projects on which Hopkins regards the cost per man employed as too high. Only a total of $13,269,700 in projects were referred by the Advisory Committee on Allotments to President Roosevelt at its meeting on Monday.

While applications for federal and non-federal projects have been piling up, the machinery of the Works Progress Administration for receiving relief works projects initiated in local communities, which generally are the type which Hopkins prefers, is very slow in getting started. State road allotments are held up because of Hopkins' decision that such projects should not exceed a cost of $1,400 per man employed, which would confine the program practically to dirt road construction.

On June 5 it was announced that the approved allotments of $400,000,000 to the states for highway and grade-crossing work had been made to the states by the Secretary of Agriculture. States must submit programs of the work to the Advisory Committee on Allotments for approval.

Projects likely to be of CWA type

All developments point to the probability that the relief works program will be made up almost entirely of projects similar to those undertaken by the Civil Works Administration, under Hopkins' direction, in the winter of 1933-34. Contractors who have been waiting for some indication of the extent to which their services will be utilized have received no assurance that any considerable volume of work will be undertaken that would require their services, even on a management fee basis.

As the cost per man employed averages approximately $2,000 on the projects so far approved the direct labor cost must average lower than $1,100 on the remainder of the program if 3,500,000 persons are to be employed This objective cannot be reached, even by stretching the imagination and allowing practically nothing for materials. Harassed by the situation arising from the Supreme Court's decision outlawing NIRA, the President apparently is giving Administrator Hopkins his head on the relief works program.

In his meetings with the Advisory Committee on Allotments the President talks entirely in terms of employment, and not of projects. There is no longer any emphasis upon projects that will return part of their cost to the federal government. There is a possibility that the allotments, totaling $1,000,000,000 recommended on May 16 by the Advisory Committee, for roads, low-cost housing and river and harbor improvement may be curtailed.

Complications delay program

Complications have arisen in practically every feature of the program. The CCC has discovered that its present enrollment of 300,000 cannot be doubled by drawing on relief rolls without further raising the age limit and modifying other eligibility requirements. No decision has been reached by the Advisory Committee on Allotments with respect to applications totaling $65,000,000 for soil erosion control and $156,000,000 for forestry work. Many other federal agencies are now uncertain as to what projects can be put forward with any prospect of being approved.

Labor Department Starts Survey Of Engineering Profession

The Bureau of Labor Statistics of the U. S. Department of Labor has begun a survey of the engineering profession at the request of American Engineering Council. Questionnaires have been sent to about 170,000 names, the membership list of national and local societies having been consolidated into a master list by FERA workers in an effort to eliminate duplication as far as possible.

The purpose of the survey is to obtain an accurate cross-section of the engineering profession from which to determine its economic status as a result of the changed economic conditions since 1929, also to provide an accurate breakdown of the profession between private and the various elements of public employment.

Arkansas Road Work Delayed Awaiting Sales Tax Ruling

The Arkansas state highway commission, after having received bids on nine road construction projects, has announced that the awarding of contracts will be withheld until the state supreme court has decided whether the two per cent sales tax recently passed is valid.

If the law is upheld the bids will be rejected and the projects readvertised as the bids submitted did not include allowances for the sales tax on materials used in construction. If the act is held unconstitutional, contracts will be awarded to the low bidders. Contractors who submitted bids sought information on which items going into road construction the sales tax would apply, but they were informed that they would have to await the ruling of the court.

Construction Is Not Interstate According to the Supreme Court

Construction is essentially an intrastate operation, according to the finding of the U. S. Supreme Court in its decision declaring NRA codes unconstitutional (Schechter Poultry Corp. *vs.* United States), noted briefly in our news pages last week. The following excerpts from the decision are of special significance to the construction industry:

"We have held that in dealing with common carriers engaged in both interstate and intrastate commerce, the dominant authority of Congress necessarily embraces the right to control their intrastate operations in all matters having such a close and substantial relation to interstate traffic that the control is essential or appropriate to secure the freedom of that traffic from interference or unjust discrimination and to promote the efficiency of the interstate service."

"The distinction between direct and indirect effect has been clearly recognized in the application of the anti-trust act. Where a combination or conspiracy is formed, with the intent to restrain interstate commerce or to monopolize any part of it, the violation of the statute is clear.

"But where that intent is absent, and the objectives are limited to intrastate activities, the fact that there may be an indirect effect upon interstate commerce does not subject the parties to the federal statute, notwithstanding its broad provisions. This principle has frequently been applied in litigation growing out of labor disputes. United Mine Workers *vs.* C. F. Coronado Coal Co.; United Leather Workers *vs.* Herkert; Industrial Association *vs.* United States; Levering & Garrigues Company *vs.* Morrin.

"In the case last cited we quoted with approval the rule that had been favored and applied in Industrial Association *vs.* United States, after review of the decision, as follows: 'The alleged conspiracy and the act here complained of spent their intended and direct force upon a local situation—for building is as essentially local as mining, manufacturing, or growing crops—and if by resulting diminution of the commercial demand interstate trade was curtailed either generally or in specific instances, that was a fortuitous consequence so remote and indirect as plainly to cause it to fall outside of the reach of the Sherman Act'."

"The question of chief importance relates to the provisions of the code as to the hours and wages of those employed in defendants' [Schechter Poultry Corp.] slaughter house market. It is plain that these requirements are imposed in order to govern the details of defendants' management of their local business. The persons employed in slaughtering and selling in local trade are not employed in interstate commerce. Their hours and wages have no direct relation to interstate commerce."

"We are of the opinion that the attempt through the provisions of the code to fix the hours and wages of employees of the defendants in their intrastate business was not a valid exercise of federal power."

Floods in Colorado, Nebraska and Kansas Cause Heavy Damage and Loss of Life

RAINS OF CLOUDBURST proportion, beginning on May 30 in Colorado and Wyoming and moving eastward across Nebraska, Kansas and Missouri for two days, precipitated major floods on the streams in the southern part of the Missouri River drainage basin as well as on the Arkansas River, a Mississippi River tributary. Over 100 lives were lost and some $25,000,000 of property damage resulted. Colorado Springs was hit first and suffered a $1,500,000 loss. Pueblo, farther south, was also damaged. Denver's famous Cherry Creek brought flood waters into town and thence into the South Platte River. Most extensive damage occurred in the Republican River Valley which coincides roughly with the Nebraska-Kansas line for about 200 miles eastward from Colorado. McCook, Neb., with a population of 4,500, was especially hard hit. As this issue goes to press the Arkansas River in Kansas and the Platte River in Nebraska are carrying their flood waters within their banks. The Kaw, taking the Republican floodwater, was rising, however, and with flood stage in the Missouri River at Kansas City was being backed up to a dangerous height, threatening to cause extensive damage. At Manhattan, Kan., parts of the business district were flooded and water surrounded about one-third of the homes in this city of 10,000 population on June 4. According to newspaper reports, the army engineers predict a Missouri River stage for June 6 at Kansas City equal to that of the 1903 flood, the worst on record. Along the Missouri eastward to St. Louis flood conditions were growing worse. The M-K-T Railway abandoned 8 miles of track near Boonville, and highways at many locations were blocked. Flood stage in the Mississippi at St. Louis was expected June 6.

Streams and towns of Colorado, Nebraska and Kansas which were seriously affected by the floods of last week.

Colorado flood

Denver and Colorado Springs, on opposite sides of the Arkansas Divide, suffered flood damage from Cherry Creek and Fountain Creek, respectively, both of which have their source along the Divide. Fountain Creek flowing south through Colorado Springs, empties into the Arkansas River at Pueblo. Colorado Springs estimates its damage at something over $1,500,000. The city water department lists a damage of $50,000, the street department, $20,000, the sewer department, $75,000, the parks department, $300,000. The South Nevada Ave. bridge, the West Colorado Ave. bridge, the Cache La Poudre bridge and the Uinta bridge were damaged to the extent of $50,000, $75,000, $40,000 and $40,000 respectively.

Between Colorado Springs and Pueblo another million dollars of damage was caused to highway and railway property. One of the major structures which collapsed was a two-span through-truss bridge of the Santa Fe Railroad over Fountain Creek. The Colorado State Hospital annex in Pueblo was undermined by Fountain Creek and had to be abandoned.

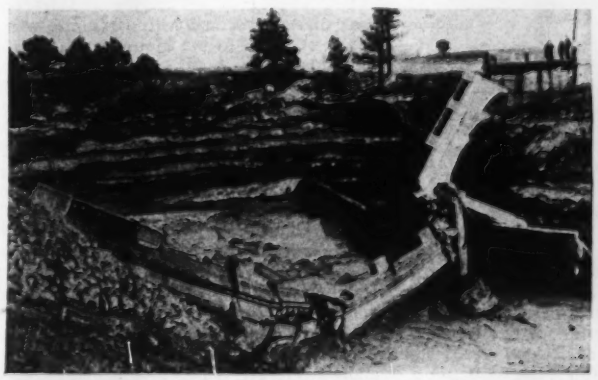
Damage to state highways and bridges will run to a million dollars total, according to reports. The worst damage was concentrated on the Colorado Springs-Denver road just south of Monument. Pine Creek bridge (see photo) was washed out, and more than a mile of paving was undermined to the point where it was impassable. Bridges over Kiowa and Bijou Creeks on the Sterling-Greeley road were also washed out.

To a large degree, the new channel of Cherry Creek in Denver carried the flood adequately. Work on the channel in southeast Denver was under way by FERA forces, who have been grading and placing riprap. About 60,000 cu.yd. of material was washed away from the south bank of the creek; this represented about one-half of the uncompleted work. No damage was done to the riprapping along the South Platte River. Two wooden pile bridges over the river at East 52d St. and Franklin St. were damaged and must be replaced.

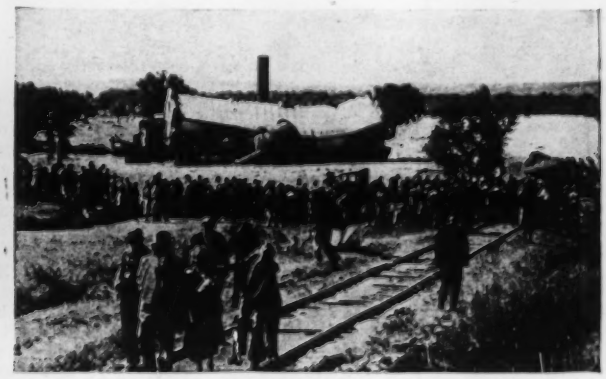
The towns of Elbert and Kiowa southeast of Denver were completely flooded. The Fort Morgan water and light plant was under water and power for pumping had to be obtained from the Great Western Sugar Co.'s plant. The power plant at Sterling was also flooded, and up and down the South Platte valley highway and railway bridges were extensively damaged. Total flood damage in Colorado was placed between $8,000,000 and $10,000,000 by Gov. Johnson.

Nebraska flood

The Republican River, rising in eastern Colorado and flowing north to the Ne-



Three-span reinforced concrete girder bridge over Pine Creek on the Denver-Colorado Springs highway after the Fountain Creek flood had subsided.



McCook, Neb., power plant which was completely wrecked by the Republican River flood which was the worst in the history of this valley.

braska-Kansas line which it parallels for 200 miles before turning south to a junction with the Kaw River in Kansas, suffered the greatest flood in its history. Total damage in the valley was estimated at $13,000,000. McCook was the hardest hit of the larger towns. The villages of Parks (between Haigler and Benkelman) and Max with a population of about 100 each were reported to have been completely washed away. The power plant of the Nebraska Light & Power Co. at McCook, a $300,000 structure, was demolished (see photo) leaving the city without power or light. Twenty-five persons lost their lives in the McCook area.

In the vicinity of St. Francis, Kan., the Republican River was reported to have cut a new channel half way across Cheyenne County. The St. Francis light plant was flooded to a depth of 5 ft. and was shut down, and all but one of the wells of the city's water supply were temporarily abandoned. At Red Cloud, Neb., the river was two miles wide and the water was 5 ft. deep in the Burlington Railroad station.

In spite of the floods in the South Platte in Colorado and high water in the North Platte, there was little danger of flood in the Platte valley because the river had been practically dry before the rain.

At South Omaha, where a new bridge is being built across the Missouri River, contractors and engineers welcomed the high water which should assist materially in shifting the channel of the river toward the west bank, where it is planned to concentrate the navigation channel. The bridge has been built on dry land up to the present channel and if the high water shifts the channel back under the completed portion, the remainder of the bridge also can be constructed on dry land (*ENR*, May 23, 1935, p. 727).

Burlington Railroad suffers

For 244 miles the Chicago, Burlington & Quincy Railroad parallels the Republican River. Damage to its track and structures was exceedingly high. According to reports from the railroad, traffic was tied up completely between Wiggins, Colo., on the west and Oxford, Neb., on the east. Three branch lines to the south, to St. Francis, Oberlin and Concordia, were out of commission with serious damage to bridges at Orleans and Republican. According to latest estimates more than 25 miles of main and branch line track were washed out. Near Wiggins, Colo., a steel plate girder bridge of two 75-ft., two 50-ft., one 65-ft. and two 26-ft. spans over Bijou Creek went out along with 600 ft. of embankment. The damage was expected to be repaired by a wood-pile bridge and shoofly by Saturday, June 8. Some 2,000 to 3,000 ft. of track in the yards at Brush were badly damaged by overflow from Beaver Creek. A 208-ft. concrete pile trestle at Parks, Nebr., and a 224-ft. trestle of the same type at Haigler were washed out. At Perry a deck plate girder bridge with two 30- and one 40-ft. spans in addition to 100 ft. of concrete pile trestle was destroyed. At Culbertson, just west of McCook, 192 ft. of concrete pile trestle collapsed. In the 108 miles, from Parks to Edison, there are about 40 bridges, exclusive of culverts, up to 100 ft. in length. Several small towns in the valley were completely isolated. At Red Cloud there was 5 ft. of water in the roundhouse, and water was extremely high at Red Willow and Indianola.

Amendment Extends Time and Scope Of FHA Program

BY AN AMENDMENT to the National Housing Act, recently approved by President Roosevelt, the FHA building modernization plan has been extended to April 1, 1936, and broadened in scope to include modernization of industrial and commercial buildings, including apartments, hotels and offices, by raising the present limit on the insured loan from $2,000 to $50,000.

FHA is still in its infancy but its regulations are designed to assure to operative builders the benefits of the insurance system, and thus to extend it to cover the bulk of new home construction. Since insuring offices were opened last December in 61 key cities, FHA received to May 25 more than 13,000 applications for insuring loans totaling $66,000,000, 33 per cent of which represents new construction. Commitments have been issued on 5,852 loans totaling $25,100,000; 5,894 applications totaling $23,800,000 are under consideration and 1,438 mortgages totaling $5,900,000 have been insured.

To make sure that the advantages of this system are available to home owners and builders, FHA will accept applications direct from the would-be borrower. If no local institution is willing or able to advance money on commitments to insure the loans, FHA turns to one of the 71 life insurance companies or to other institutions that have earmarked some portion of their resources for investments in insured mortgages. Approximately $326,000,000 has been allocated for this purpose to date. The total does not include funds from many approved institutions that have made no definite allotments of funds.

Better housing standards

Besides stabilizing the value of existing homes by a uniform method of appraisal, FHA is seeking to raise the standards of new housing by putting more emphasis upon sound construction and careful community planning.

To encourage new ideas and to help their originators build in volume FHA's technical division has certified as acceptable for use in property, otherwise eligible for mortgage insurance, methods of construction using prefabricated steel and composition building materials. Specifications and test data on new methods of construction may be submitted to the technical division directly or through the field offices. When a ruling on acceptability is issued, copies are furnished to all FHA field offices for reference in considering applications for insurance of mortgage loans.

The Federal Housing Administration believes that mortgage insurance affords an opportunity for private investment in low-cost housing of the group dwelling and apartment house types, independent of PWA's subsidized slum clearance projects. Five limited dividend housing developments totaling $11,400,000 have been approved to date as eligible for insurance of the mortgage loans. These are located at Meadville, Pa., $900,000; Clarendon, Va. (Washington, D. C.), $1,130,000; Brooklyn, N. Y., $8,000,000; LaGrange, Ill., $158,500, and Dundalk (Baltimore), Md., $1,289,140.

Washington Highlights

By PAUL WOOTON

Powers of the Federal Home Loan Banks have been widened in a bill which became law May 28. Loans now may be made to non-members of home financing organizations on the security of home mortgages insured under title 2 of the National Housing Act. Loanable resources are expanded; the authorized bond issue is increased to $4,750,000,000; funds are made available for reconditioning mortgaged houses; investors in home financing organizations are allowed a 50% reduction in insurance premiums.

All types of construction and the sale and rental of real estate will be covered in a nation-wide census of business to be undertaken by the Census Bureau employing white collar relief labor. The Bureau filed an application this week for an allotment of $9,370,000. Enumeration will commence Jan. 1, 1936, and a preliminary report will be available in May or June for the calendar year 1935.

Pending bills proposing to shear some of the power of the Supreme Court have little chance of adoption. The high court is so well entrenched in the respect and confidence of the people that little political support for such action is expected. There is some support for a constitutional convention to consider possible revision of the fundamental law.

Under pressure from the Administration Congress is expected to bring out some substitute for the NRA which will meet the objections raised in the Schechter case but the chief responsibility for the orderly conduct of business is thrown back upon industry itself. Agreements along the line of the Appalachian Coals are expected to come to the fore.

A change in the value of the franc, in the opinion of financial experts in Washington, is inevitable. Many of them believe such action will aid world recovery.

Johnson Bill Meets Opposition In House Committee

The Johnson bill, which was formulated in an effort to legalize construction of Parker Dam and other projects which had been put on the doubtful list by the Supreme Court's action in the suit by the state of Arizona, met with opposition when it was referred to the House flood control committee.

The bill which specifically authorized the completion of Parker Dam and by inference legalized a number of other projects was introduced into the Senate shortly after the Parker Dam decision (*ENR*, May 23, 1935, p. 757). It passed through the Senate without difficulty and was referred to the House committee on flood control. Five members of the committee; Carlson, Kan.; Kimball, Mich.; Tobey, N. H.; Rich, Pa., and Gehrmann, Wis., wno formed a minority, filed a report not objecting to the legalization of Parker Dam, but opposing authorization of Grand Coulee Dam and other projects that deal primarily with land reclamation and power development on the ground that they are contrary to the present land policy.

Indian Earthquake Destroys Large Cities And Takes Heavy Toll of Lives

TWO CITIES of 60,000 population each, Quetta in northwestern India and Kandahar in Afghanistan, were devastated by a major earthquake on May 31. The loss of life is reported as high as 56,000, which exceeds that in any Indian earthquake on record. The only other earthquakes which have exacted a greater toll of life were in 1908 in Italy when 76,000 persons lost their lives and in 1923 in Japan when there were 99,000 killed.

Quetta abandoned

Quetta, which was so badly damaged as to be virtually evacuated by the survivors, is capital of Baluchistan and an important British military and railway center. Some 200 Britons are reported among the dead. Located about 400 miles north of Karachi, Quetta is in the foothills of the Himalayas. It has an elevation of 5,500 ft. above sea level and is surrounded by mountains attaining an elevation of 11,000 ft. In a district of sharp topographical differences, it has been subjected to many earthquakes, but none so serious as the one of last Friday.

According to reports, the second and third shocks were the heaviest. Four-fifths of the buildings in the city were destroyed, including the railway station and civil station, the general hospital and the large palace of the Khan of Kalat nearby. Severe damage was suffered at the airdrome where hangars collapsed, destroying many military planes. Floods following the earthquake added to the damage and loss of life. News from Kandahar has been meager, but it apparently suffered as greatly as did Quetta.

Buildings of adobe

None of the reports described the type of structures which were prevalent in the area, although it is well known that the majority of all houses in Indian cities are of adobe built up in very thick walls as protection against the extremes of temperature. The last destructive earthquake in India occurred in January, 1934, near Bihar in the northeastern part of the country. An as yet unpublished report of the damage sent to this journal by Mason Vaugh of the Agricultural Institute of Allahobad and his assistant, A. T. Mosher, probably reflects in general the type of damage suffered in Quetta. Mr. Vaugh was formerly on the faculty of the University of Missouri. According to Vaugh and Mosher, building construction in the Bihar area (and probably also in Quetta) may be divided into three broad types. The first of these, which includes the greater part of all buildings, is composed of one-story homes and shops with walls of built-up mud or unburned brick laid up in mud and covered by a roof of tiles laid on bamboo mats supported by wooden beams. Such structures offer little resistance to earthquake forces. The second type of building is of brick construction, the brick laid up either in mud or in weak lime mortar to form a wall 16 to 24 in. thick. Some of these buildings are two and three stories high and often of considerable size. Roofs are flat, supported by beams or jack arches. The third type of construction in the area is reinforced masonry, some brick and some concrete. Wood is hardly used at all in buildings in the Bihar area. The acceleration of the Bihar shock was estimated at 10 to 11 ft. per second. The intensity of the Quetta earthquake has not been reported.

Albany Power Authority Created by New Law

A bill creating the Albany Light, Heat, and Power Authority has been signed by Governor Lehman of New York. The law gives the power authority unusually broad powers allowing it to operate both in Albany and adjoining counties.

The establishment and operation of a county-owned power plant either through new construction or through purchase or condemnation proceedings of existing facilities of privately owned companies is provided for in the law. Duplication of existing systems is prohibited and the financing of the proposed county-owned system is limited to a $10,000,000 bond issue which must be approved by a referendum.

Contract Awarded on PWA Housing in Montgomery, Ala.

Construction of another PWA housing project is about to get under way with acceptance of the bid of $376,500 of T. L. James & Co., Ruston, Louisiana, for construction of the Thurman Street project in Montgomery, Ala. According to PWA the original allotment of $315,000 for this project has been increased to $459,000, to meet requirements of the development. The project, which will replace an objectionable slum area, will provide 158 living units in modern row houses, each with its own yard and garden space.

Construction of the Montgomery project will commence immediately after the signing of the final contract documents by Administrator Ickes, following their execution by the contractor. This construction has been preceded by construction work on two Federal projects in Atlanta, Ga., and on seven limited dividend corporation housing projects, three of which are occupied. The fourth, as noted on the cover of this issue, is being opened this month.

The Thurman Street project will provide two, three, four and five-room row houses. Occupying an irregularly shaped tract of land of some 311,000 sq.ft. opposite the campus of the Alabama State Normal School for Negroes the project will create a model community, with the row houses grouped around courts.

CALIFORNIA PACIFIC INTERNATIONAL EXPOSITION OPENED

Air view taken above Ford Hill on the opening day of the San Diego fair shows the new buildings grouped in the foreground with the older Panama Pacific Exposition buildings set a short distance away. On the hill below the Ford Building and Music Bowl are the Famous Roads of the World; various sections of this drive are facsimiles of famous roads throughout the world. At the far end of the plaza is the Standard Oil building and alongside of the Music Bowl is the Palace of Electricity. Directly across the plaza from the Palace of Electricity is the California State Building.

Purdue Launches Research Plan On Science of Better Living

With a dramatic setting of 120 business executives, industrialists and scientists the Purdue Research Foundation at a homes conference, June 1, at Lafayette, Ind., launched an elaborate research on housing. The purpose is to bring those who make and sell together, to meet consumer demands of modern civilization, to encourage the more general use of available scientific data to the advantage of the housing industry, to attempt a more rapid and reliable solution of the housing problem and to consider ways and means of stimulating the vast army of potential home-owners to immediate activity.

The Foundation, which financially is not directly connected with Purdue University, has received a donation of 143 acres of land upon which it is proposed to build a residential development to represent ideal living conditions, not only from the physical standpoint but equally with reference to such social matters as public health, public safety and recreation. Plans are to be handled largely—by the university staff, with advice and counsel from the building industry and other interests. The present plan is to build 10 to 20 houses, each one as a demonstration of some important advancement in plan, construction or equipment. University people will live in the houses on a lease basis.

Laboratory to be built

A striking feature is the erection of an "all weather" laboratory, a large structure within which full sized houses can be erected and tested under artificially controlled temperatures, moisture and other weather conditions.

As principal speaker at the conference Owen D. Young, General Electric Co., compared farmhouse conditions of 50 years ago with modern conveniences now available, stressing air conditioning. Housing, he said, is one field of durable goods wherein unemployment is greatest, but in urging research in the material field he did not forget to state that "we need the most and best research in a new finance which will make mortgages the convenient tool of the home owner and the safe medium of the investor, instead of as now, the executioner's axe of the home owner and the destroyer of the savings of he who lends." In consequence he was emphatic in urging that the schools of finance and economics undertake a concurrent job of research. Some of the major points Mr. Young brought out forcibly are as follows: Costs are too high for the buying power of the great masses of the people; ways must be found to cut costs. If prefabrication is the only way of accomplishing that result he welcomed the prefabricated house. No inflation of money will bridge the gap. Cost of housing must be reduced relative to other costs, which can only be done by research and efficiency.

Advanced designs sought

In outlining details of the housing research plan Edward C. Elliott, president of the Purdue Research Foundation as well as president of Purdue University, indicated that the advanced design and construction sought would include not alone framework, walls, roof and foundation but equally heating, ventilation, air conditioning, laundry and kitchen facilities. In searching for improvement not only are lower first costs sought but also reduced depreciation, fire hazard and repairs. Through pre-arrangement with the tenants data of every kind will be gathered, including structural soundness, fuel costs, maintenance costs, performance of mechanical equipment, insulating value, air conditioning performance, performance of interior and exterior wall materials and endless other subjects dealing with the practical and cultural life of the family, many of which cannot be studied satisfactorially by means of artificial laboratory procedure.

Engineering Index Forms Group To Aid Continuation of Work

The *Engineering Index* has practically completed its national committee which is to solicit funds for the continuation of the *Index*.

From 1919 to 1933 the *Engineering Index*, which is a service listing and annotating all types of engineering literature, was published by the American Society of Mechanical Engineers. In 1933 the A.S.M.E. had to forego its publication because of the expense, and a group of men continued the work, forming a non-profit corporation in 1934.

According to Dean C. P. Bliss of the College of Engineering, New York University, the funds being solicited are to finance a plan for increasing the number of subscribers and for decreasing the cost of subscription to the index service.

SOCIETY CALENDAR

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting, Detroit, June 24-28.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual convention, Los Angeles, July 3-5.

PENNSYLVANIA SEWAGE WORKS ASSOCIATION, annual meeting, State College, Pa., June 24-26.

NEW ENGLAND WATER WORKS ASSOCIATION, fall convention, Providence, R. I., Sept. 17-20.

NEW YORK STATE SEWERAGE WORKS ASSOCIATION, fall meeting to be held in conjunction with the NEW ENGLAND SEWERAGE WORKS ASSOCIATION, Schenectady, N. Y., Oct. 4-5.

ERIE COUNTY CHAPTER, New York Society of Professional Engineers, at the annual meeting elected the following officers: president, STEWART S. NEFF; vice-president, H. A. STELLEY; treasurer, ARTHUR WEAVER; secretary, ELY ANDERSON.

ENGINEERING SOCIETY OF BUFFALO at a recent meeting elected the following officers: president, E. T. LARKIN; vice-president, A. L. KIMBALL; secretary, T. L. MAYER; treasurer, R. T. MCKEEGAN.

MIDSOUTH SECTION, American Society of Civil Engineers at the annual meeting May 24-25 elected officers as follows: president, G. R. CLEMENS; vice-president, J. H. GARDNER; secretary-treasurer, D. M. MCCAIN.

LOUISIANA SECTION of the American Society of Civil Engineers recently elected the following officers: president, E. P. HAMILTON; vice-presidents, C. H. STEM and H. A. SAWYER; secretary, C. M. KERR; treasurer, A. N. FROMHERZ.

STATE EXAMINATIONS for registration of engineers and land surveyors are scheduled to be held in the near future as follows:

OREGON—By the State Board of Engineering Examiners for Registration of Professional Engineers, July 5-6, at the office of the Board in Portland.

Pigeon River Project Permit Denied by Power Commission

A preliminary permit to the Pigeon River Lumber Co. of Minnesota for a proposed water power project of seven dams and a power plant on Pigeon River has been denied by the Federal Power Commission.

From 1924 to 1927, the company held a preliminary permit for a project covering five sites for dams proposed in its recent application but did not file an application for license to construct the project before expiration of that permit.

In an opinion denying the second application for preliminary permit, the power commission held that "it is contrary to the public interest to grant now a second preliminary permit, as the only purpose which could be served thereby would be to extend the period of priority of application beyond that contemplated by the statute." Also it was held that the applicant had, under the previous permit, made all of the preliminary examinations and acquired all of the information necessary to the filing of an application for a license.

Personals

R. A. KIZER, formerly valuation engineer for the Union Electric Light & Power Co., St. Louis, has accepted a position as structural designer for the Phelps-Dodge Corp., in Douglas, Ariz.

ROBERT WHEATLEY, Salineville, Ohio, has been appointed resident engineer of Columbiana County, Ohio.

NATHAN L. SMITH, chief engineer of the Maryland state roads commission, has been appointed a member of the Maryland state planning commission.

W. N. GLADSON, engineer member of the Arkansas department of public utilities, has tendered his resignation effective as of June 1. Mr. Gladson has been dean of the College of Engineering at the University of Arkansas for many years.

FRANK D. KING has been appointed office engineer in the department of works, Louisville, Ky. Mr. King, a graduate of Alabama Polytechnic Institute, at one time was employed by the state highway commission. He has been in private engineering practice for the past eight years.

JOHN P. H. PERRY, deputy director of the Works Division, Emergency Relief Bureau of New York City, has resigned that position and on July 1 will return to the Turner Construction Co. Mr. Perry, who has been associated with the Turner Construction Co. for 28 years, will now become vice-president and director.

REAR ADMIRAL HAROLD G. BOWEN has assumed the duties of Engineer in Chief and Chief of the Bureau of Engineering, Navy Department, relieving REAR ADMIRAL SAMUEL M. ROBINSON. Rear Admiral Robinson has been ordered to the General Electric Co., Schenectady, N. Y., as Inspector of Naval Material.

GEORGE F. UNGER, chief engineer of the Niagara Frontier State Park commission, has been appointed general superintendent of the Grand Island bridges, in charge of

operation and maintenance. ALBERT C. COLE has been appointed executive secretary of the Niagara Frontier State Park commission. In his new position, he will have charge of developing the two Grand Island parks.

R. A. MACGREGOR, chief of maintenance of highways and sewers in Manhattan Borough, New York City, for the past ten years, has retired. Mr. MacGregor, who for 38 years has been connected with the borough presidents' offices in the Bronx and Manhattan, started his engineering experience with the North British Ry. Co. in Edinburgh, Scotland, in 1884. He came to the United States in 1890 and after working on various engineering projects in the South he began work in the Borough of the Bronx and later, after holding various other positions in the city, became chief of maintenance.

Obituary

OLAF OFFERDAHL, 76, civil engineer for the Washington state highway department, died in Seattle on May 13.

JAMES FINNEY, 69, who assisted in designing the beach protection works of the Rockaway peninsula, died recently at his home in Far Rockaway, N. Y.

WILLIAM B. DORSEY, 78, died in Norwalk, Conn., May 15. Mr. Dorsey had been a bridge construction engineer for over 50 years. At one time he was construction engineer for the New England Engineering Co.

CHARLES D. MILLS, civil engineer, died at his home in Sussex, N. B., May 5, at the age of 75. At one time he was a member of the staff of the New Brunswick Central Ry. In 1907, he was appointed town engineer for Sussex, N. B., and continued in this position until 1927.

ALEXANDER L. HUPE, engineer for the Louisville Water Co., died there on May 24 after a long illness. Following his graduation from Cornell University, he was employed by the Louisville Bridge & Iron Co., and was later promoted to the position of chief engineer. He then was employed by the water company to assist with the design and construction of a filter plant. Mr. Hupe, at one time, had been employed as construction engineer on the Kentucky & Indiana Terminal R. R. Co. bridge across the Ohio River. Mr. Hupe was a member of the American Water Works Association, American Society of Mechanical Engineers and the Engineers and Architects' Club of Louisville.

CONSTRUCTION STATISTICS OF THE WEEK

ENGINEERING contract awards total $19,672,000 for the week, a drop from the high volume of awards last week which represented only a 4-day week. Of this total $11,086,000 represents public construction, of which $3,003,000 is for federal work, $8,083,000 for state and municipal, and $8,856,000 for private work.

Industrial buildings at $1,737,000 are very much below the record volume of last week which accounts for the low volume of total contracts. Public buildings at $3,033,000 and commercial buildings at $2,111,000 are higher. Bridges at $2,495,000, waterworks at $699,000, sewers at $1,294,000 and unclassified private at $3,788,000 are higher, while streets and roads at $2,877,000 and earthwork and waterways at $1,291,000 are lower.

The larger contracts include: high school at Olean, New York, $650,000; superstructure for Ashland Avenue Bridge, Chicago, $458,000; bridge on Main Street, Columbus, Ohio, $316,000; sanitary sewer and sewage disposal plant improvements at El Paso, Texas, $405,000. The private awards include buildings in connection with a race track for the Eastern Horse Racing Association, Boston, estimated to cost $2,500,000, and an experimental television coaxial cable from New York to Philadelphia with amplifying stations for the American Telephone and Telegraph Co., New York, estimated to cost $580,000.

New capital for the week totals $530,275,000, of which $9,478,000 is for state and municipal and $520,797,000 for federal, the first expenditures to be approved under the federal relief works act. This has been allotted as follows: $400,000,000 to the Bureau of Public Roads; $8,611,000 to the Bureau of Yards and Docks; $107,186,500 to the War Department, Corps of Engineers; $5,000,000 to the Department of Interior, Reclamation Service.

CONTRACTS
(Thousands of Dollars)

	Weekly Average June 1934	Prev. 4 Weeks	Week June 6 1935
Federal Government	$5,624	$4,581	$3,003
State and municipal	17,343	12,027	8,083
Total public	$22,967	$16,608	$11,086
Total private	4,531	9,513	8,586
Week's total	$27,498	$26,121	$19,672
Cumulative to date:			
1934...$643,182,000	1935...$566,782,000		

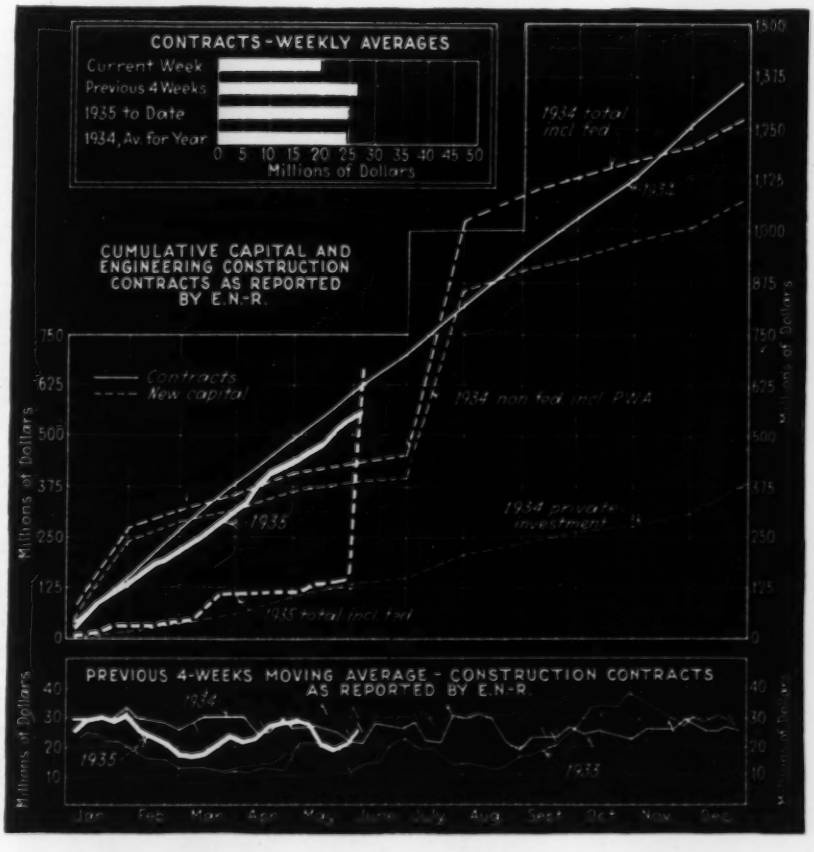
NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

1935	Week June 6	Cumulative
State and municipal	$9,478	$181,078
PWA allotments, S&M	.....	—49,032
RFC loans, S&M	.....	84
Corporate issues	.....	.....
PWA allotments, private	.....	8,619
Total, Non-Federal	$9,478	$140,749
PWA allotments, Federal Constr.	520,797	531,848
Total new capital	$530,275	$672,597
Cumulative to date:		
1934...$435,751,000	1935...$672,597,000	

Note: These figures include private bonds, and stocks sold for productive purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities, including the special highway funds; PWA private loans, and allotments for Federal construction. Negative amounts in PWA totals indicate excess of rescissions and reductions over reallotments and increases in outstanding allotments.

INDEX NUMBER

E.N.R.-Cost	1913 = 100	1926 = 100	E.N.R.-Volume	1913 = 100	1926 = 100
June, 1935	194.78	93.63	May, 1935	100	53
May, 1935	194.06	93.28	Apr., 1935	130	57
June, 1934	199.61	95.95	May, 1934	101	44
1934 (Av.)	198.10	95.23	1934 (Av.)	114	50
1933 (Av.)	170.18	81.80	1933 (Av.)	102	47
1932 (Av.)	156.97	75.45	1932 (Av.)	127	56


CONTRACTS - WEEKLY AVERAGES
Current Week
Previous 4 Weeks
1935 to Date
1934, Av. for Year
0 5 10 15 20 25 30 35 40 45 50
Millions of Dollars
CUMULATIVE CAPITAL AND ENGINEERING CONSTRUCTION CONTRACTS AS REPORTED BY E.N.-R.
Contracts
New capital
1934 total incl. fed.
1934 non fed. incl. PWA
1934 private investment
1935
1935 total incl. fed.
Millions of Dollars
PREVIOUS 4-WEEKS MOVING AVERAGE - CONSTRUCTION CONTRACTS AS REPORTED BY E.N.-R.
1934
1935
1933
Jan Feb Mar Apr May June July Aug Sept Oct Nov Dec

BUSINESS SIDE OF CONSTRUCTION

Private Construction Increases; Public Works Reflect Delays

PRIVATE engineering construction for the first five months of this year was the heaviest of any similar period in the last three years, showing a gain of 38 per cent over 1934. Federal construction is only 58 per cent of that of last year for the five-month period, and a distinct slowing up of state and municipal work pending a start of the new public works program has pulled the total of all construction for the first five months down to 91 per cent of the corresponding 1934 volume. The total construction volume to date this year, as reported by *Engineering News-Record*, is $547,110,000, of which $396,943,000 is public works. At the end of May last year the reported total volume was $602,981,000, with $493,247,000 in public works. The highway field shows the greatest loss for the year, this class of work amounting to only 70 per cent of that of last year.

As predicted early this year, industrial building has shown a substantial gain these first five months, with reported contracts reaching 72.3 millions, a gain of 71 per cent over the corresponding period of 1934. Commercial building activity shows little change, but miscellaneous private work has gained 58 per cent.

May volume

Engineering construction contracts reported in May, 1935, (five weeks) total $122,827,000, or an average of 24.5 millions per week. This is a drop from the average of 29.2 millions for the previous month. Every class of construction showed a loss for May as compared with April, except industrial building, which averaged 5.7 millions per week as compared with 4.8 millions in April. Highway awards remained stationary at 4.6 millions per week, a low figure for this time of year. In a geographical distribution of contracts the Middle West district showed a spurt, awards here being almost double those of April, while the May contracts in every other part of the country were below those for April.

The *E.N.-R.* Cost Index for June shows a slight increase due to a small rise in the average of labor rates, the index now standing at 194.78. For four months the Cost Index has showed little variation. The Volume Index for May dropped to 109 from the 130 mark for April.

New capital

State and municipal bond sales reported in May total $32,499,000, while continued

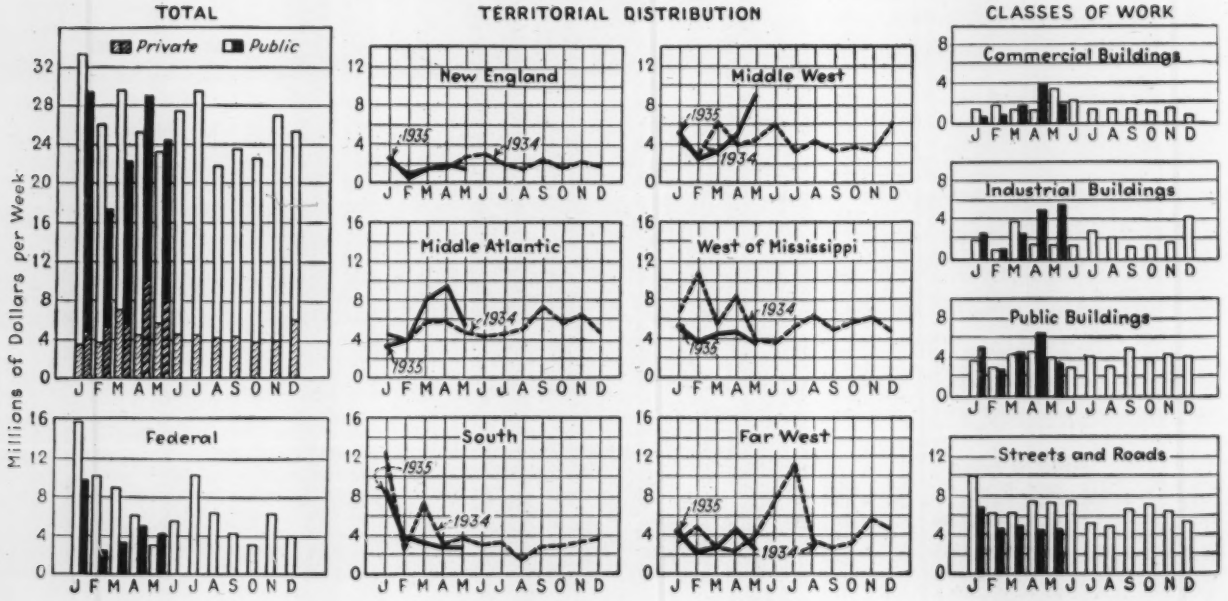
ENGINEERING CONSTRUCTION CONTRACTS REPORTED IN MAY, 1935

Five Weeks—Thousands of Dollars—(000 Omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States May 1935	United States Five Months 1935	United States Five Months 1934	Canada
Public Works										
Waterworks	1,712	613	135	726	1,003	2,492	6,681	31,518	19,728	36
Sewers	42	2,353	211	6,548	281	163	9,598	28,358	22,939	482
Bridges, public	123	969	440	653	1,293	1,353	4,831	27,990	42,622	..
Earthwork and waterways	117	487	2,816	7,204	943	2,399	13,966	75,377	130,195	127
Streets and roads	1,560	3,845	5,281	3,733	6,642	2,169	23,230	113,753	162,539	1,384
Buildings, public	440	5,343	1,734	1,745	5,279	2,812	17,353	97,661	87,101	792
Unclassified, public	919	2,993	433	203	602	338	5,488	22,286	28,123	61
Total public	4,913	16,603	11,050	20,812	16,043	11,726	81,147	396,943	493,247	2,882
Federal gov't (included in above classifications)	989	1,562	3,543	8,041	3,574	2,579	20,288	110,878	187,972	..
Private										
Bridges, private	....	146	....	17	333	....	496	5,433	6,351	..
Buildings, industrial	548	2,398	2,064	21,702	799	979	28,490	72,292	42,353	3,868
Buildings, commercial	180	7,121	100	1,349	460	56	9,266	39,203	39,958	300
Unclassified, private	643	722	168	953	168	774	3,428	33,239	21,072	..
Total private	1,371	10,387	2,332	24,021	1,760	1,809	41,680	150,167	109,734	4,168
May, 1935 (5 weeks)	**6,284**	**26,990**	**13,382**	**44,833**	**17,803**	**13,535**	**122,827**	.....	.....	**7,050**
April, 1935 (4 weeks)	7,513	37,066	10,864	20,561	19,180	21,788	116,972	.....	.....	1,185
May, 1934 (5 weeks)	13,923	23,276	18,548	22,555	19,407	19,034	116,743	.....	.....	10,492
Five months, 1935	34,141	130,006	95,204	113,349	97,359	77,051	.....	547,110	.....	23,029
Five months, 1934	39,892	110,294	129,090	99,044	150,889	73,772	.....	.....	602,981	19,758

ENGINEERING CONSTRUCTION REPORTED BY E.N.-R.-WEEKLY AVERAGES

□---1934 ■—1935



rescissions in previous PWA allotments pulled the net new money available for construction in May down to $26,098,000. For the first five months state and municipal bond sales total $171,600,000, as compared with $129,077,000 for the corresponding period of 1934. Because PWA rescissions this year have been greater than allotments, the total of all new financing is only $142,322,000, as compared with $429,949,000 up to June 1 of last year, including PWA allotments.

Materials

Cement—The portland cement industry in April, 1935, produced 6,136,000 bbl., shipped 6,196,000 bbl. and had in stock at the end of the month 21,229,000 bbl., according to a report of the Bureau of Mines. Production was 6.2 per cent below that of April, 1934, while shipments showed a drop of 4.6 per cent over a year ago. Both production and shipments have shown a steady increase since February, when they were both at the 3,000,000 bbl. stage. The Bureau reports the mill value of cement shipped the first quarter of this year at $16,513,000, including high-early-strength cement valued at $584,000.

Steel—The steel industry was operating at a rate of 42.3 per cent of capacity at the first of June, as compared with 43.1 per cent a month ago and 56.1 per cent a year ago, according to the American Iron & Steel Institute. During the first four months the industry produced a total of 11,013,306 gross tons, considerably greater than the 9,813,593 tons reported for the corresponding period of 1934. The American Institute of Steel Construction reports that 72,983 tons of structural steel were booked during April, 1935, with 65,017 tons shipped. Both of these figures are greater than the monthly average during the first quarter.

The steel construction industry experienced its worst volume and prices during the past three years, according to a report just issued by the American Institute of Steel Construction. Despite the large expenditures for public works the sale of fabricated structural steel has not recovered. The tonnage of steel sold for municipal, state and federal projects during 1933 and 1934 was appreciably less than that volume sold for similar projects in 1930, 1931 or 1932. The report, inclusive from 1923 through 1934, also gives the range of prices during these years. The low volume in structural steel tonnage was reached in 1933, with sales of only 830,000 tons. The high volume was in 1929, when sales soared to 3,600,000 tons. The average, 1923-1929, was 2,895,000 tons. Last year the volume was 1,020,000 tons. Tonnage for private work dropped from 1,600,000 in 1929 to 40,000 in 1933, rising to 160,000 last year. Using the average price, 1923-1929 as 100 for an index, the price index stood highest in 1923, 105, and dropped to 69 in 1932, recovered slightly in 1933 to 70 and rose to 78 last year.

Lumber—The strike in the Western lumber mills is curtailing production, according to the National Lumber Manufacturers Association. Unfilled orders on hand May 18 were 867 million bd.ft., with gross stocks on hand at 4,387 million ft. Shipments, as well as production, had dropped to January levels. New business, was, however, 50 per cent above production and shipments were 23 per cent above output.

The Department of Commerce has received a report from the Special Lumber Survey Committee on lumber consumption, stocks and anticipated consumption for the second quarter of 1935. The Committee reports expected lumber consumption during the first half of 1935 as 7 per cent greater than during the corresponding period of 1934, and a reduction in stocks during the first three months of 300 million ft. The report indicates as desirable a further reduction in national stocks of 900 million ft.

Prices

Prices of construction commodities during May remained fairly stationary, except for lumber, which showed increases in many trading centers. The West Coast strike will further increase prices, according to a prominent distributor. Our Atlanta correspondent reports lumber is scarce in that area with prices advancing. Baltimore prices for all commodities are upset by a sales tax fight. Steel and cement prices remained steady at all points.

It is too early to note the effect of the codes on code-controlled prices.

Building permits

Building permits, as reported by Dun & Bradstreet, for April are the heaviest of any month in several years, totaling $51,637,233, a gain of 76 per cent over the corresponding month of last year. Those for New York City total $12,643,378, a gain of 92 per cent over the April, 1934, total. The sharp rise registered since the first of this year, especially during March and April, has brought the total estimated cost of building permits for the first four months of 1935 to $151,163,720, as compared with $94,937,690 in the same period of 1934, and an increase of 102 per cent over the low volume of 1933. These figures are for 215 comparable cities.

Labor

Average labor rates on construction work reported from twenty cities showed little change for the month. The announcement of minimum relief works wages far below prevailing hourly rates created considerable excitement in labor circles, but as more than half the volume of work to be financed by the new program is exempt from the low-rate provisions, it is not contemplated that existing wage scales will be seriously disturbed. Code-controlled wage scales are expected to show some change in the near future, but very little construction was actually being carried out under code scales, as most work was subject to wage regulation other than by code.

Gains of 11 per cent in employment and 12.1 per cent in payrolls in April were reported by 10,395 contractors engaged in private building work. Employment in the production of six major construction materials in April was 41.2 per cent of the 1923-1925 average, as compared with 40 per cent in March and 41.6 per cent in April, 1934.

In New York state the construction industry showed a gain of 19 per cent in employment during April. More than 900 employees were added to the payrolls of 222 building contractors, while highway contractors added considerably to their forces.

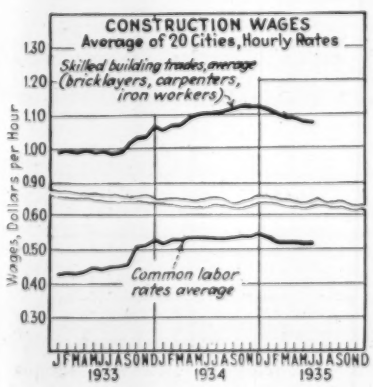
Kansas City ironworkers agreed to a 60-day extension of the old wage scale of $1.12½ per hr. for the second time. Unions are asking for $1.50 and a 6-hr. day, which is being opposed by the Builders' Association.

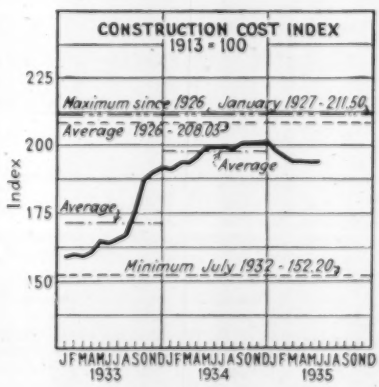
EN-R Cost and Volume Index

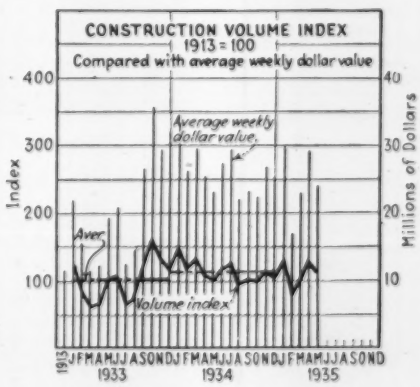
The Engineering News-Record Construction Cost Index is 194.78 for June, a slight increase over the May value, due to an upward fluctuation in common labor rates. The *E.N.-R.* Volume Index for May is 109, a considerable drop from the 130 value of April.

INDEX NUMBER

E.N.R.-Cost	1913 = 100	1926 = 100	E.N.R.-Volume	1913 = 100	1926 = 100
June, 1935	**194.78**	**93.63**	**May, 1935**	**109**	**52**
May, 1935	194.06	93.28	Apr., 1935	130	57
June, 1934	199.61	95.95	May, 1934	101	44
1934 (Av.)	198.10	95.23	1934 (Av.)	114	50
1933 (Av.)	170.18	81.80	1933 (Av.)	102	47
1932 (Av.)	156.97	75.45	1932 (Av.)	127	56


CONSTRUCTION WAGES
Average of 20 Cities, Hourly Rates
Skilled building trades, average (bricklayers, carpenters, iron workers)
Common labor rates average
Wages, Dollars per Hour
1.30
1.20
1.10
1.00
0.90
0.60
0.50
0.40
0.30
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1933
1934
1935


CONSTRUCTION COST INDEX
1913 = 100
Maximum since 1926, January 1927 - 211.50
Average 1926 - 208.03
Average
Average
Minimum July 1932 - 152.20
Index
225
200
175
150
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1933
1934
1935



CURRENT PRICES OF CONSTRUCTION MATERIALS

CEMENT, AGGREGATES AND READY-MIXED CONCRETE—F.O.B. CITY

	PORTLAND CEMENT — Per bbl., carload lots, including 40c. per bbl. for bags, cash discount not included			SAND AND GRAVEL — Per ton, carload lots			CRUSHED STONE Per ton, carload lots		CRUSHED SLAG Per ton, carload lots, f.o.b. plant		CONCRETE Ready Mixed 1:2:4, 50 yd. or more, delivered
	Cloth Bags*	Paper Bags	Bulk	Gravel, 1½ in.	Gravel, ¾ in.	Sand	1½ in.	¾ in.	1½ in.	¾ in.	
Atlanta	$2.89	$2.64	$2.44	$2.31	$2.31	$1.64	$1.69	$1.92	$1.80	$1.80	$8.25
Baltimore	2.66	2.41	2.21	1.80‡	2.00‡	1.25‡	1.80‡	1.80‡	2.25	2.25	7.50
Birmingham	2.55	2.30	2.10	1.75	1.75	1.40	.85	.85	.90	1.15	5.45
Boston	2.72	2.47	2.27	1.50	1.50	1.10	1.50	1.50	.....	.....	7.00
Chicago	2.95‡	2.70‡	2.40	2.60‡	2.60‡	2.05‡	2.60‡	2.60‡	.....	.....	.....
Cincinnati	2.57	2.32	2.12	1.20	1.20	1.10	1.80	1.80	.....	.....	6.70
Cleveland	2.45	2.20	.....	1.55	1.55	1.45	1.60	1.60	1.75	1.75	8.85
Dallas	2.45	2.20	2.00	1.55	1.55	1.30	2.10	2.25	.....	.....	7.00
Denver	3.08	2.83	.....	1.85	.....	1.25	.....	.....	.....	.....	.....
Detroit	2.25	2.00	1.80	1.40	1.30	1.20	1.40	1.50	1.40‡	1.50‡	6.25
Kansas City	2.50	2.25	2.05	.....	1.85	1.15	1.85	1.40-1.55	.....	.....	7.65
Los Angeles	2.70	2.42	.....	1.60	1.60	1.20	1.60	1.60	.....	.....	6.70
Minneapolis	2.90	.....	2.45	1.00[p]	1.00[p]	.25[p]	1.00[p]	1.00[p]	.....	.....	6.25
Montreal	.....	1.70	.....	.85	.90	.40	.85	.95‡	.....	.....	6.00
New Orleans	2.40	2.22	2.00	1.75	1.75	1.45	.....	.....	.....	.....	8.25
New York	2.60‡	2.35‡	.....	1.30†[k]	1.30†[k]	.85†[k]	1.75†[k]	1.85†[k]	.....	.....	7.60
Philadelphia	2.63	2.38	2.18	1.80‡	1.90‡	1.50‡	1.75‡	2.00‡	1.00‡	1.00‡	7.75
Pittsburgh	2.45	2.20	1.60	1.50‡	1.50‡	1.70‡	2.25‡	2.25‡	1.50	1.50	7.00
St. Louis	2.53	2.28	.....	1.00‡	1.00‡	1.00	.75[p]	.75[p]	.65/.95§A	.50/.95§B	6.65
San Francisco	2.72	2.52	2.20	1.35	1.35	1.35	1.50	1.50	.....	.....	7.53
Seattle	2.95	2.70	.....	1.00	1.00	1.00	1.44	1.44	.....	.....	7.56

*10c. allowed for each returnable bag. †Per cu. yd. ‡Delivered. §F.o.b. Granite City, Ill. A Above 5/16" size, B 5/16" and below—new code sizes. [kBarge lots alongside dock. [pf.o.b. plant. [s5 tons or more.

CURRENT MAXIMUM NET PRICES RECEIVED AT CEMENT MILL

Charge for bags not included. For cloth bags, add 40c. per bbl.; 10c. refund allowed for each returnable bag; for paper bags add 15c. per bbl., not refundable.

	Bagged	Bulk		Bagged	Bulk		Bagged	Bulk
Alpena, Mich	$1.65	$1.45	Ironton, Ohio	$1.60	$1.55	North Birmingham, Ala.	$1.75	$1.70
Buffington, Ind	1.70	1.65	Iola, Kans	1.70	1.65	Richard City, Tenn	2.00	1.95
Crestmore, Calif	1.72	....	La Salle, Ill	1.60	1.55	Saginaw, Mich	1.50	1.45
Dallas, Tex. (Inc. 5c. tax)	1.80	1.75	Limedale, Ind	1.70	1.65	Steelton, Minn	1.80	1.75
Hannibal, Mo	1.70	1.65	Mason City, Ia	1.70	1.65	Universal, Pa	1.65	1.60
Hudson, N. Y	1.75	1.70	Norfolk, Va	1.76	1.71	Waco, Tex. (Inc. 5c. Tax)	1.80	1.75
Independence, Kans	1.70	1.65	Northampton, Pa	1.65	1.60	Wyandotte, Mich	1.45	1.40

Cash Discounts, Cement, to Contractors: truck delivery, 2% for cash on 10th of month; on carload deliveries, no trucking, same as dealer cash discount, 10c. per bbl. for payment within 15 days of date of invoice.

STRUCTURAL CLAY BUILDING TILE, BRICK AND LIME—DELIVERED

	STRUCTURAL CLAY TILE — PARTITION—SCORED — Per M, lots of 2,000 pieces or over, 3x12x12 in.	4x12x12 in.	8x12x12 in.	STRUCTURAL CLAY TILE — LOAD BEARING—SCORED — Per M. lots of 2,000 pieces or over, 8x12x12 in.	10x12x12 in.	12x12x12 in.	BRICK — Per M, in quantity, Common backing	Straight hard	LIME — Per ton, Hydrated finishing	in paper, Common hydrated	carload lots, Pulverized or lump
Atlanta	$75.80	$80.80	$151.60	$181.90	$212.20	$242.50	$14.25	$14.25[e]	$24.00	$17.00	$15.90
Baltimore	75.25	81.00	151.50	181.80	210.50	262.60	13.00	17.00	17.00	11.50	19.25
Birmingham	84.25	90.00	156.00	180.00	215.00	242.00	15.00	22.50	3.00§	1.75§	2.25[e]
Boston	85.30	91.15	171.00	193.50	239.60	273.40	14.50	18.00	18.75	13.75	3.26[g][e]
Chicago	66.00	70.40	132.00	.....	.....	.....	10.20	11.20	18.00	13.40	14.00
Cincinnati	70.45	74.95	140.50	168.65	210.00	260.00	17.50	17.50	15.97	12.48	.....
Cleveland	62.50	66.50	124.50	149.50	188.00	214.75	16.50	16.50	17.20k	14.40k	2.65k[p]
Dallas	72.00	75.00	197.00	177.00	217.00	269.00	13.50	26.00	21.20	14.50	1.70 [g]
Denver	78.50	88.00	141.50	166.50	196.00	225.00	10.00-15.50	21.00-30.00	25.00	17.00	20.00
Detroit	71.85	76.65	143.70	230.00	280.00	325.00	11.50	12.50	14.25	11.90	22.00
Kansas City	72.50	75.50	92.00*	140.50	177.75	207.25	15.00	24.00	15.00	11.25	14.00*
Los Angeles	77.50	94.25	134.00*	188.00	232.50	311.50	11.50	14.00	18.70	.....	19.70
Minneapolis	80.15s	85.50s	145.40s	167.75s	175.25s	243.70s	13.10	15.10x	25.50	21.00	23.00
Montreal	79.10s	90.40	169.50s	.....	212.40	.....	17.00	22.50	23.00	13.00	.....
New Orleans	61.60	65.70	123.20	158.90	196.70	.....	14.00	.....	16.75	13.05	.....
New York	84.00	90.00	135.00*	193.30†	238.80†	295.60†	11.50	.....	20.80	16.00	20.80
Philadelphia	80.50	85.90	161.00	182.50	235.00	272.00	15.00	18.00	16.35	11.25	10.75
Pittsburgh	72.65c	77.45c	145.00c	165.00c	217.00c	250.00c	17.50	22.00	16.70	15.10	2.75[p]
St. Louis	62.00	65.00	120.00	165.00	187.00	214.00	15.00	18.00	.48‡	.38‡	2.80[g]
San Francisco	84.00	94.50	225.00	.....	.....	.....	15.00	18.00	22.50	21.50	2.05[p]
Seattle	86.00	94.50	210.00	198.00	.....	.....	15.00[d]	18.50	30.00	26.00	3.00[p]

*6x12x12 in. †F.o.b. Perth Amboy, N. J. ‡Per sack. §Per bbl., 200 lbs. [pPer bbl. 180 lbs. [gper bbl. 280-lb. kLCL. [dless $1 cash 15 days. [elump. [sSmooth. x Selected common.

ROAD SURFACING MATERIALS—F.O.B. CITY

	PAVING BRICK AND BLOCKS — Granite per M, lots of 50,000, 4x4x8 in.,	Brick per M, 3x8½x4 in., carload lots	Wood per sq.yd., 3½ in., 16-lb. treat,	PAVING ASPHALT — Per ton, less than 80 penetration, Tank car	Drums	ASPHALT BINDERS—FLUXES — Per gal., 80-300 penetration, Tank car	Drums	CUTBACK ASPHALT — Per ton, Tank car	Drums	ROAD OILS — Per gal., Tank car	ASPHALT EMULSION — Per gal., Tank car	Drum
Atlanta	$ 89.00	$35.00	$2.25	$17.40[z]	$22.57[z]	$0.0494[z]	$0.911[z]	$15.90[z]	$23.82[z]	$0.0586[z]	$0.105	$0.10
Baltimore	110.00	44.00	2.35	17.00	22.00	.07	.095	.085†	.12†	.....	.....	.....
Birmingham	110.00	24.00	.....	18.00	23.00	0.778	.1028	.082†	.112†	.....	.06	.....
Boston	100.00	30.00	2.75	16.00	21.00	.075	.10	.09†	.12†	.075	.09	.125
Chicago	125.00	42.00	2.60	.....	.....	.....	.....	.....	.....	.....	.....	.....
Cincinnati	110.00	37.00	.....	18.00	22.00	.09	.....	18.50	.....	.07	.08	.....
Cleveland	100.00‡	32.75	2.95	20.00	24.50	.075	.09	.075†	.049†	.06	.085	.10
Dallas	.....	30.00	.....	16.10	21.10	.0525	.10	15.65	23.15	.055	.1076	.1438
Detroit	.....	37.00	.....	19.67[z]	24.87[z]	.....	.....	17.00	22.50	.....	.0957	.....
Kansas City	.....	45.00	.....	18.30	23.30	17.30#	22.30#	.075†	.105†	.055	.11	.15
Los Angeles	.....	50.00	.....	10.34	14.50	10.34#	14.50#	10.34	.....	.042	.06	.12
Minneapolis	.....	.....	2.50	18.20	24.70	.098	.098	21.85	34.65	.048	.....	.....
Montreal	.....	110.00	.....	14.00	19.66	.07	.093	19.00	26.00	.07	.125	.155
New Orleans	100.00	32.00	.....	14.50	18.50	.065	.09	.07†	.10†	.....	.....	.....
New York	130.00§	50.00	2.64	17.00	22.00	.07	.095	.085†	.12†	.....	.075	.11
Philadelphia	122.00	45.00	2.25	13.50	18.00	.05	.08	.05†	.08†	.05	.02	.....
Pittsburgh	120.00	40.00	.....	19.00	24.00	.0775	.1125	.086†	.121†	.0675	.....	.....
St. Louis	115.00	35.00	2.00	19.70	24.70	.078	.109	.09†	.12†	.04	.09	.125
San Francisco	.....	50.00	.....	12.00	18.00	12.00#	18.00#	12.50#	23.00#	.04	.0575	.117
Seattle	.....	55.00	.....	17.00	23.00	17.00#	23.00#	15.00	.....	.03	.19	.20

Note: Paving asphalt, tank car or boat, f.o.b. Maurer, N. J., per ton, Bermudes, $25.00; Trinidad, $21.00. *Per sq. yd. †Per gallon. ‡4½x6x5½in. #Per ton §4x5x9-in. Av. [zMexican. [zlocal reduction due to 20% reduction intra-state class freight rates, only Georgia affected.

CURRENT PRICES OF CONSTRUCTION MATERIALS

IRON AND STEEL PRODUCTS—BASE MILL PRICES

	STRUCT. SHAPES-PLATE	REINF. BARS ½-in. billet,	RIVETS ½-in. structural	WIRE NAILS Base	SHEET PILING Base	STEEL RAILS Per Gross Ton Standard	Light	Re-rolled	TRACK SUPPLIES Angle bars	Std. spikes	Tie plates	Track bolts
Birmingham	$1.95	$2.10	.....	.....	.....	$36.375	$34.375	$35.00	$2.55	$2.40	$1.90	$3.55
Chicago	1.85	2.10	$3.00	.....	$2.25	36.375	35.00	34.00	2.55	2.40	1.90	3.55
Pittsburgh	1.80	2.05	2.90	$2.60	2.15	36.375	35.00	34.00	2.55	2.40	1.90	3.55

IRON AND STEEL PRODUCTS—BASE MILL PRICES, PER 100 LB., CARLOAD LOTS

F.O.B. WAREHOUSE	STRUCTURAL SHAPES Per 100 lb., base price	REINFORCING BARS Per 100 lb., ½ in., base price New billet	Rail steel	EXPANDED METAL LATH —Per 100 sq yd., carload lots— Std. diamond mesh, 3.4 lb	Std. ribbed 3.4 lb.	WELDED FABRIC REINFORCING —Per 100 s.f., carload lots— 4x16 in., No. 5 & 10 wires	4x12 in., No. 8 & 12 wires	6x6 in., No. 6 & 6 wires Per sq yd	SHEET PILING Per 100 lb., base price
Atlanta	$3.36	$2.34	$2.19	$21.00	$23.00	$1.53	$1.16	$0.1449	$2.70
Baltimore	2.95	2.75	2.60	23.00	25.00	1.41	1.08	.1332	2.75
Boston	3.55	3.18	2.25	21.00	25.00	1.46	1.12	.1449	2.35
Chicago	3.20	2.10	1.95	22.00	26.00	1.40	1.08	.1323	2.25
Cincinnati	3.40	3.25	3.25	25.01	29.50	1.39	1.07	.1282	.....
Cleveland	3.16	2.60	2.45	20.00	22.00	1.37	1.06	.1287	.....
Dallas	3.25	2.80	2.65	22.00	25.00	1.63	1.23	.1548	2.985
Denver	3.93	3.87	.....	25.00	27.50	1.68	1.26	.1548	.....
Detroit	3.40	2.885	2.885	20.00†	22.00	1.41	1.08	.1323	2.25
Kansas City	3.70	2.70	2.55	19.00	21.00	1.50	1.14	.1422	2.70
Los Angeles	3.10	2.95	.....	23.00	27.50	1.68	1.26	.1584	2.50
Minneapolis	3.45	2.86	2.71	22.00	26.00	1.51	1.15	.1431	2.55§
Montreal	2.75	3.00	2.80	.....	.....	2.30	1.71	.238	2.65
New Orleans	.....	.....	.....	19.15	23.00	1.54	1.17	.1458	.....
New York	3.37	2.86	2.71	20.00	22.00	1.44	1.11	.1359	2.48
Philadelphia	2.98	3.06	2.22	20.00	24.00	1.42	1.09	.1332	2.46
Pittsburgh	1.80‡	1.80‡	1.70‡	20.75‡	23.00‡	1.34	1.04	.1260	2.15
St. Louis	3.45	2.95	2.80	22.00	24.00	1.42	1.09	.1341	2.25
San Francisco	3.55	2.475	2.35	23.00	28.00	1.68	1.26	.1584	2.60
Seattle	3.50	2.50	.....	30.00	33.00	1.68	1.26	.1584	2.60

‡Base Mill Price. Note: Shapes, bars and piling subject to quantity discounts. §Mill Price plus freight to Minneapolis. †f.o.b. delivered.

PAINTING AND ROOFING SUPPLIES—F.O.B.

	RED LEAD Per 100 lb. in 500-lb. lots Dry	WHITE LEAD Per 100 lb. in 500-lb. lots# in oil	READY-MIXED PAINT Per gal., drums Graphite*	Aluminum†	Ferric Oxide‡	ROOFING SUPPLIES Carload lots, f.o.b. factory Rolls, slate surfaced, 85-90 lb., per sq.	Asphalt felt, per 100 lb.	Tar felt, per 100 lb.	Asphalt coating, per gal.	Tar pitch, 350-lb. bbl., per ton
Atlanta	$7.75	$10.50	$1.60	$3.10	.....	$1.81	$1.97	$2.90	$.36	$25.40
Baltimore	7.00	10.00	1.40	2.25	$1.90	2.32	2.55	2.55	.48	24.60
Birmingham	7.25	10.50	2.35	2.35	1.85	2.20	1.79	.....	36	23.00
Boston	7.00	10.00	1.85	2.75	.04¾x	2.05	3.00	3.00	.43	20.00
Chicago	7.00	10.00	1.85	2.45	1.30	1.60	1.59◦	1.59◦	.24	20.00
Cincinnati	7.00	10.00	1.45	2.50	1.40	2.40	2.39◦	2.39◦	.36	21.00
Cleveland	7.00	10.00	1.65	2.30	1.30	1.60	1.79	1.79*	.24	22.00
Dallas	7.25	11.00	1.80	2.24	.....	2.40k	4.17	4.17	.15	35.00
Denver	7.50	10.75	2.55	.....	.....	2.75	3.46	3.46	.60	30.00
Detroit	7.00	10.00	1.45	2.20	1.30	2.55	2.80	2.80	.37	30.00
Kansas City	7.00	10.12½	1.25	2.25	1.00	2.05	3.10–3.20	3.10–3.20	.23	26.50
Los Angeles	7.25	10.25	1.60	2.25	2.30	2.00	1.50	.....	.45	.....
Minneapolis	7.00	10.12½	.....	.....	.....	1.60	1.79*	1.79*	.29	25.80
Montreal	.....	9.40	1.70	3.45	1.65	2.00	2.62	2.02	1.40§	1.52§
New York	7.00	10.00	1.60	2.00	1.40	1.60	1.79*	1.79*	.232	22.00
Philadelphia	7.00	10.00	2.50	2.95	1.50	1.68	1.85*	1.48*	.37	22.00
Pittsburgh	7.00	10.00	1.05	1.95	.80	1.75	1.65*	1.65	.38	22.00
St. Louis	11.00	11.00	1.85	2.45	1.30	1.87k	3.22	3.22	.28	20.00
San Francisco	7.25	10.25	1.80	2.75	1.10–2.00	1.89	3.10	3.10	.38	26.00
Seattle	7.25	10.25	1.80	2.85	2.25	3.30	2.66	2.60	.60	30.00

*U. S. War Dept. Spec. 3-49A. †ASTM Spec. D266-31. ‡80% maximum ferric oxide. §Per 100 lb. *Per roll, 65 lb. xPer lb. ◦500-lb. drums.
Note: Red lead in oil 50c higher than white lead in oil. #Basis of quoting changed this month from list to 500-lb. lots.

MISCELLANEOUS ITEMS

WINDOW GLASS

Discounts from latest jobbers list, Sept. 15, 1928

	Single or Double Thickness A quality	B quality
Atlanta	85%	85%
Baltimore	88–10%	90–10%
Birmingham	88%	90%
Boston	88–10–5%	90–10–5%
Chicago	90%	92%
Cincinnati	89–10%	91–10%
Cleveland	89-10%	91-10%
Dallas	87%	89%
Denver	84%	86%
Detroit	87–10%	89–10%
Kansas City	87–10%	88–10%
Los Angeles	90%*	90–40%
Minneapolis	85%	87%
Montreal	.....	.....
New Orleans	88%	90%
New York	88%	90%
Philadelphia	89%	91%
Pittsburgh	88%	88%
St. Louis	90%	92%
San Francisco	90%	90–2½%
Seattle	90–10%	90–20%

*Disc. from list Aug. 1, 1929.

EXPLOSIVES

Per lb. dynamite delivered 50-lb. cases

	Gelatin 40%	60%
Atlanta	$0.155	$0.17
Baltimore	.16	.175
Birmingham	.105	.120
Boston	.17	.1725
Chicago	.....	.....
Cincinnati	.27	.29
Cleveland	.19	.205
Dallas	.17	.185
Denver	.155	.17
Detroit	.237	.255
Kansas City	.16	.175
Los Angeles	.1725†	.1925†
Minneapolis	.17	.185
Montreal	.1875	.2125
New Orleans	.19	.22
New York	.225	.24
Philadelphia	.1550	.17
Pittsburgh	.11	.1250
St. Louis	.135	.15
San Francisco	.1525	.1775
Seattle	.1425	.1575

†F.o.b. Arsenal. ‡Double thickness A & B

CHEMICALS

Water, sewage treatment, road work, f.o.b., carlots, New York	
Bleaching powder, in drums, f.o.b. works, per 100 lb.	$1.90@$2.15
Calcium chloride, 77-80%, flaked, in 400-lb. drums or 100-lb. moisture proof bags, f.o.b. works, freight equalized with points of competition, per ton	22.00@35.00
Chlorine cylinders, per lb. delivered	.05½
Silicate of soda, 52 deg., in drums, f.o.b. works, per 100 lb.	1.35
Soda ash, 58%, in paper bags, per 100 lb	1.20
Sulphate of aluminum, commercial, in 100 lb. bags per ton	27.00
Sulphate of copper, in bbl., per 100 lb.	3.85

PILES

Prices per linear foot, pine, with bark on f.o.b., New York; delivered from barge, 1½ to 2c. per ft. additional:

Dimensions	Points	Length	Short Leaf Barge	Short Leaf Rail	Long Leaf Barge	Long Leaf Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.12	$0.165	$0.13	$0.16
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.16	.21	.15	.20
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.17	.225	.16	.21½
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.195	.235	.20½	.24½
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.2125	.245	.24½	.30½
14 in.—2 ft. from butt	5 in.	80 to 85 ft.	.275	.385	.....	.....
14 in.—2 ft. from butt	5 in.	85 to 89 ft.	.315	.452	.....	.....

RAILWAY TIES

Prices f.o.b., per tie, for carload lots:		6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
Boston	Oak, untreated	$1.20	$1.75
	Pine, untreated	1.25	1.75
	Pine, creosoted	1.70	2.40
New York	Long-leaf sap pine, untreated	.80	1.00
	Mixed oak, untreated	.....	1.00
Birmingham	White oak, untreated	.75	1.50
	White oak, creosoted	no market	
	Southern pine, untreated *6x8x8'6"	.45*	.60
	Southern pine, creosoted	1.00	1.20
Chicago	White oak, untreated	1.15	1.40
	Oak, empty cell, creosoted	1.50	1.88
	Oak, sinc treated	1.40	1.70
	Southern pine, creosoted	1.35	1.78
Los Angeles	Fir, untreated	.50	.72
	Fir, creosoted	1.67	2.40
Philadelphia	Red oak, untreated	1.05	1.35
	Red oak, creosoted	1.50	1.90
	White oak, untreated	1.03	1.35
St. Louis	Red oak, untreated	.95	1.30
	Red oak, creosoted	1.40	1.90
San Francisco	Sap Pine or cypress, untreated	.80	1.20
	Douglas fir, green, untreated	.45	.63
	Douglas fir, empty cell, creosoted	1.14	1.56
Montreal	Birch or maple, untreated	1.00	1.10
	Birch or maple, creosoted	1.25	1.55

CURRENT PRICES OF CONSTRUCTION MATERIALS

WATER, SEWER AND DRAIN PIPE

	C. I. PIPE	VITRIFIED SEWER PIPE				CLAY DRAIN TILE		CONCRETE SEWER PIPE		WROUGHT STEEL PIPE			
	Per net ton, f.o.b. 6 in. to 24 in.*	Per foot, delivered, standard (‡ f.o.b.) 8 in., s.s.	12 in., s.s.	24 in., d.s.	36 in., d.s.	Per 1,000 ft., carload lots, f.o.b. 6 in.	8 in.	Per ft., delivered; ASTM C 14-24 12 in.	24 in.	Full standard weight. # 1 to 3 in., Butt Weld Black	Galv.	3½ to 6 in., Lap Weld Black	Galv.
Atlanta	$43.00	$0.225	$0.405	$1.4625	$3.25	$80.00	$128.00	$0.55	$1.60	44%	37%	42%	34%
Baltimore	46.50	.25	.50	2.10	5.75	106.00	166.50	.75	2.00				
Birmingham	39.00	.25	.45	1.625	4.66	85.00	200.00	.45	1.60	48.939%	37.918%	50.162%	39.143%
Boston	46.50	.231	.4455	2.025	5.945	60.10	101.00	.54	2.00				
Chicago	47.50	.28	.54	1.98	5.60	85.00	120.00	.675	2.25	56%	45%	55%	37%
Cincinnati	46.00	.231	.4455	1.935	5.8425	69.00	108.00	.40	1.40	53.04%	42.02%	54.265%	43.24%
Cleveland	47.50	.196	.378	1.62	5.0225	47.25	72.00	.536	2.102	58.4%	48.4%	60.6%	49.6%
Dallas	51.00	.25	.45	1.80	.....	160.00	250.00	.41	1.41	64%	53%	64%	56%
Denver	59.00	.23‡	.415‡	1.73‡	.....	.....	.....	.....	.....	56%	45%	43%▲	57%
Detroit	47.50	.245	.4725	2.025	5.74	58.10	97.20	.35	1.55	48.6%	38.2%	47.3%	37.6%
Kansas City	49.00	.32	.57	2.27	4.90	120.00	240.00	.35	1.20	56%	47%	57%	48%
Los Angeles	47.50	.2825‡	.508‡	2.03‡	5.535‡	115.50	192.50	1.00	2.00	53.57%	43%	53%	42.51%
Minneapolis	49.50	.255	.459	1.836	4.67	.....	.....	.50	1.34	.....	.....	.....	.....
Montreal	.....	.80	1.50	6.00	.....	45.00	90.00	.45	.....	.....	.....	.....	.....
New Orleans	45.00	.32	.51	1.65		67.00	.....	.45	2.00				
New York	46.00	.26	.51	2.25	6.75			.55	2.00	51.88%▪	40.86%▪	53.10%▪	42.08%▪
Philadelphia	43.00	.336	.648	2.835	.....	175.00	210.00	.54	1.80	52.37%▪	41.35%▪	53.39%▪	42.57%▪
Pittsburgh	49.00	.224‡	.432‡	1.845‡	5.535‡	69.00	108.00	.75	1.75	64%	55%	65%	56%
St. Louis	46.00	.22	.396	1.584	3.96	85.00	172.00	.80	2.28	51.266%	40.245%	52.49%	41.47%
San Francisco	47.00	.265	.477	1.908	5.22	103.50	172.50	.45	2.20	52.4%	63.4%	51.1%	64.6%
Seattle	48.50	.34†	.60†	2.40†	6.30†	80.00	175.00†	.50†	1.80	60.3%	51.3%	65.3%	52.3%

*b. & s. class B and heavier, C/L lots, 200 tons and over. Burlington, N. J. (base) $43.00. Gas pipe and class A, $3 per ton additional. 4-in., $3 per ton additional. 30 in. and larger usually $2 per ton less. ‡Price at factory. †Less 30% in C/L Lots.

#Discounts from standard list for delivery from warehouse, except Pittsburgh prices are f.o.b. mill. Base price $200 per net ton. List prices per ft.: ¼ in., 8½c; ⅜ in. 11½c.; 1 in. 17c.; 2 in., 37c.; 2½ in., 58½c.; 3 in., 76½c.; 4 in., $1.09; 6 in., $1.92.
▲2½ to 3 in. ▪Resale price to consumer, car load lots shipped from mill.

LUMBER AND TIMBER—PER M FT. B.M., CARLOAD LOTS F.O.B.

		SHORT LEAF YELLOW PINE AND DOUGLAS FIR—All S. L. Y. P. is No. 2 common or better and for No. 1 N. C. Box. All Fir planks No. 2 common; Fir timber is No. 1 common. Lengths up to 20 ft.								LONG LEAF Y. P. Merchantable grade up to 20 ft.	
		1x6,S	1x8,S	2x4,S	2x6,S	2x8,S	2x10,S	3x12,R	6x12,R	2x12,R	12x12,R
Atlanta	Southern Pine	$16.00	$16.00	$18.00	$18.50	$20.00	$19.50	$28.00	.....	$38.50	$40.00
Baltimore	Southern Pine	23.50	23.50	29.00	28.50	28.50	31.00	37.50		55.00	56.00
	Douglas Fir	28.50	28.00	30.50	28.50	30.50	30.50	30.50	$35.00	$30.50	
Birmingham	Long Leaf	14.25	15.25	17.25	15.25	16.25	16.25	38.00	.....	28.00	35.80
	Southern Pine	14.25	15.25	16.00	14.00	15.00	15.00	25.00	25.00	24.00	.....
Boston	Southern Pine	33.00	34.00	40.00†	42.00†	57.00‡	66.00‡	78.00‡	.....	78.00	78.00
	Douglas Fir	32.00	33.00	40.00	41.00	41.00	43.00	46.00	46.00	46.00	
Chicago	Southern Pine	27.00	28.00	33.50	30.00	31.00	32.80	45.00	.....	54.00	58.00
	Douglas Fir	28.50	29.50	31.50	30.50	30.50	28.50	40.75	41.75	41.75	.....
Cincinnati	Southern Pine	24.00	25.00	26.00	25.00	25.50	26.50	40.00	.....	31.50	.....
	Douglas Fir	.....	.....	.....	.....	.....	.....	43.50	46.25	46.25	
Cleveland	Southern Pine	26.00	28.00	32.00	28.00	30.00	32.00	45.00	43.00	.....	48.00	58.00§
Dallas	Southern Pine	d28.35	30.60	31.50	29.80	30.15	30.15	50.40	.....	.....	42.75	67.95
Denver	Douglas Fir	40.00	40.00*▪	43.00*	43.00*	43.00*	45.00*	49.00*	53.00*	61.50		
Detroit	Southern Pine	24.00	24.00	25.00	24.50	24.50	25.50	35.00			29.00	41.50
	Douglas Fir							41.50	41.50	41.50		
Kansas City	Southern Pine	22.50	23.50	23.50	22.50	23.50	24.50	35.00			47.50	57.50
	Douglas Fir	22.75	23.75	26.00	25.00	25.00	26.50	35.00	35.00	35.00	.....	.....
Los Angeles	Douglas Fir	24.00„	25.50„	26.00„	26.00„	26.00„	26.00„	38.00„	30.00„	34.00„	.....	.....
Minneapolis.c	Western Pine	45.00*	51.50*	50.00*	41.00*	41.00*	42.00*	59.50*▪			.....	.....
	Douglas Fir	39.00*	42.00*	43.50*	41.00*	41.00*	42.00*	59.50*	59.50*	59.50	58.00	.....
Montreal	Spruce	30.00	31.00	27.00	29.00	30.00	35.00	38.00	.....	.....	.....	.....
	Douglas Fir	42.50	42.50	42.50	44.00	44.00	45.75	51.00	51.00	51.00	43.00	.....
New Orleans	Southern Pine	24.25	26.50	32.00	26.50	27.90	27.90	39.50	.....	.....	45.00	55.00
	Douglas Fir	28.95	31.50	33.90	29.35	32.90	33.95	37.95	.....	.....	.....	.....
New York	Southern Pine	34.00*	35.00*	34.00*	35.00*	36.00*	37.00*	45.00*			70.00*	70.00*
	Douglas Fir	.....	.....	38.00*	38.00*	38.00*	39.00*	38.00*	42.00*	42.00*	.....	.....
Philadelphia	Southern Pine	30.00	31.00	32.00	32.00	33.00	34.00	36.00			36.00	42.00
	Douglas Fir	45.00	45.00	45.00	45.00	45.00	45.00	45.00	42.00	42.00	.....	.....
Pittsburgh	Southern Pine	26.50	27.75	32.75	29.25	31.75	32.75	41.50	.....	.....	57.50	57.50
	Douglas Fir	33.50	34.50	34.50	33.50	34.00	34.25	46.25	46.25	46.25	.....	.....
St. Louis	Southern Pine	28.00*x	29.00*x	29.00*x	28.00*x	29.00*x	29.50*x	50.00*x			56.00*x	67.00*x
	Douglas Fir							55.00*x	55.00*x	55.00*x	.....	.....
San Francisco	Douglas Fir	15.00t	16.00t	17.00t	14.50t	15.50t	16.50t	21.00	21.00t	21.00t	.....	.....
Seattle	Douglas Fir	13.00	14.00	14.00	11.50	12.50	12.00	18.50	18.00	18.00	.....	.....

*Delivered. †Spruce. ‡Long-leafed Y. P. §Norway Pine. ▲Northern Pine. =Native. tAt ship's tackle. „Yard prices. ▲10% Disc. taken off. x5M ft. or less. S4S. RRgh. cContractors in Minneapolis and St. Paul get 20% disc. from list.

CURRENT BUILDING AND CONSTRUCTION WAGE RATES PER HOUR

	Bricklayers	Carpenters	Structural Iron Workers	Hoisting Engineers	Plasterers	Common Labor Building	Common Labor Heavy Const.
Atlanta	$0.70/1.125	$0.40/.90	$0.60/1.25	$0.60/1.25	$0.60/1.00	$0.30/.40	$0.30/.40
Baltimore	1.25	1.10	1.37½	1.25	1.25	.45	.40
Birmingham	1.00	.60/1.00	1.00	1.125	1.00	.30/.40†	.30/.40†
Boston	1.20	.70/1.17½	1.20	.90/1.37½	1.37½	.50/.70	.50/.70
Cincinnati	.80/1.375	.65/1.20	1.25	1.00/1.25	.90/1.375	.45	.45
Chicago	1.50	1.31¼	1.35	1.31¼	1.50	.82½	.82½
Cleveland	1.25	1.12½	1.25	1.25	1.25	.72	.72
Dallas	.50/1.00	.50/1.00	.50/1.00	.50/1.00	.50/1.00	.25/.40	.25/.40
Denver	.60/1.12½	.60/.87½	.60/.87½	.60/.87½	.....	.50	.50
Detroit	1.25	1.00	1.25	.75/.95	1.25	.55/.60	.55/.75
Kansas City	1.32½	1.12½	1.125	1.12½	1.32½	.70	.45/.50
Los Angeles	1.10	1.10	1.125	1.10	1.25	.50	.60
Minneapolis	.90/1.00	.75	.90	.75	.90	.40	.50
New Orleans	1.00	.75	1.00	1.00	1.25	.30/.40	.30/.40
New York	1.50	1.40	1.65	1.50/1.65	1.50	.82½	.50/.82½
Philadelphia	.35/1.25	.65/1.10	.70/1.10	.90/1.00	1.10/1.37	.35/50	.40/.50
Pittsburgh	.50/1.00	.50/1.00	.50/1.00	.50/1.00	.50/1.00	.35/.50	.35/.50
St. Louis	1.50	1.25	1.47	1.37½	1.50	.78½	.35/.78
San Francisco	1.50*	1.10	1.37½	1.12½	1.25*	.62½	.60
Seattle	.90/1.00	.90/1.00	1.00/1.30	1.00/1.25	.90/1.50	.45/.65	.50/.65
Montreal	1.00	.70	.80	.55	.80	.40	.25

Skilled Avg: (Bricklayers, Carpenters, Ironworkers) $1.0736 Common Avg. $0.5269 *6-hr. Day. †PWA.